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Cold Fusion and New Energy Technology

Volume 5, Issue 26 • 1999

Reaching the New Energy Frontier

**James "Scotty" Doohan
Helps Lead the Way
in a New Cold Fusion
Documentary**

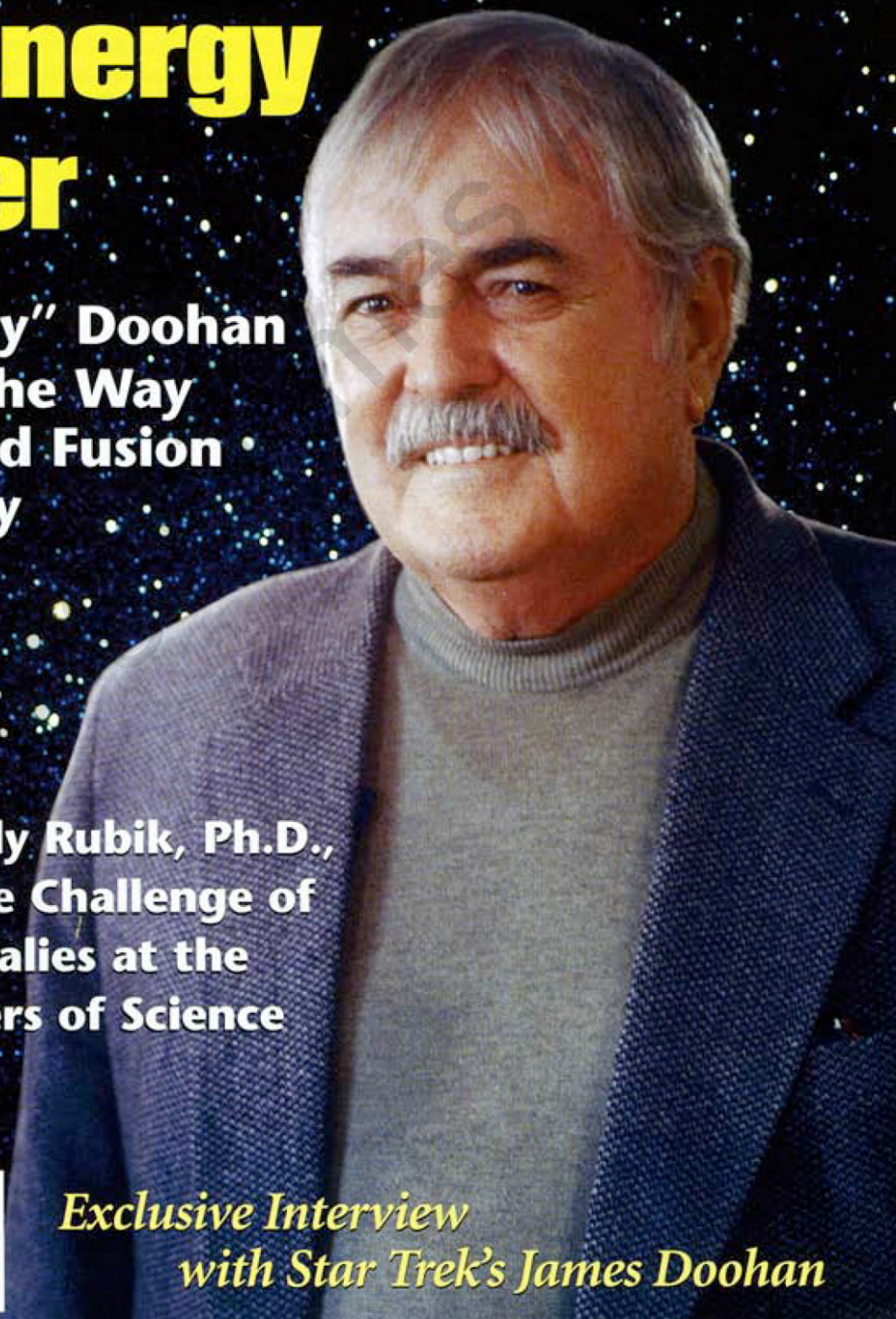


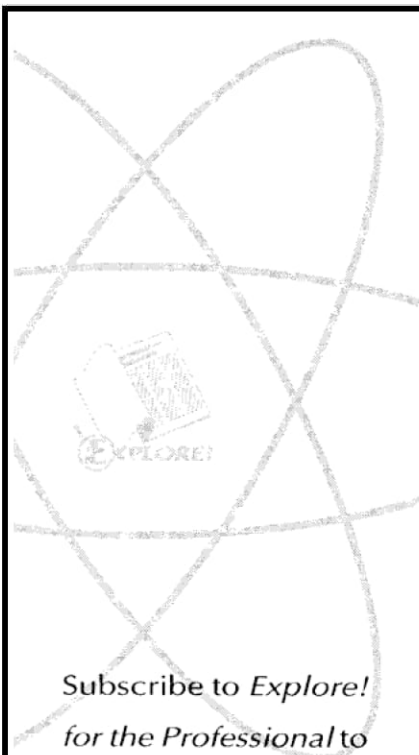
**Beverly Rubik, Ph.D.,
on the Challenge of
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Cold Fusion and New Energy Technology

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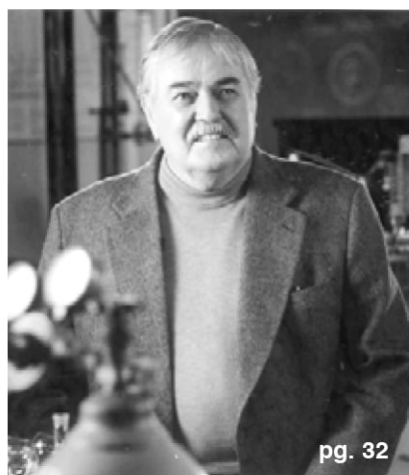
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by Dr. Eugene F. Mallove
Editor-in-Chief *Infinite Energy* Magazine
and author of *FIRE FROM ICE*

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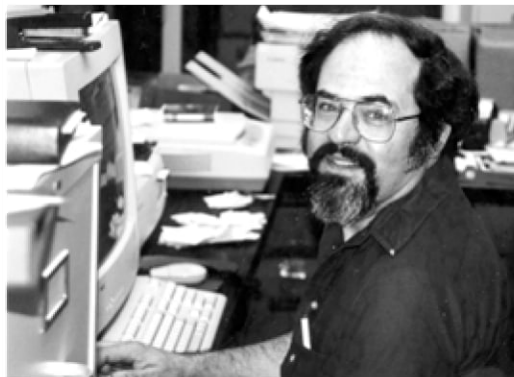
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The Power of the Sun. . .Down to Earth



By Eugene F. Mallove, Sc.D.

Pouring across every square meter of the surface of a large sphere centered on the Sun, with the radius equal to the average distance of Earth from the Sun, are about 1.4 kilowatts of electromagnetic power. Day in and day out, sunlight illuminates our little world and gives life to its surface inhabitants through a complex food chain. (Those microbial denizens of the very deep—kilometers beneath the rocky surface—may exist without benefit from the Sun, or so we are beginning to understand.)

Devotees of solar energy have built passionate careers around the power of sunlight, diluted as it is from its 1.4 kilowatt per square meter strength in airless low-earth orbit—realm of space shuttles and space stations. There are those too who have made ambitious plans to capture the intense power of sunlight in space on vast, delicate structures in high orbit, akin to spaceborne leaves. Converted to microwave power, this would be transmitted to huge antennae on the ground, and thence to the electric power grid. A recent book, *Solar Power Satellites: A Space Energy System for Earth* (by Peter Glaser et al., John Wiley & Sons, 1998) describes these vaunting ambitions.

Alas, the heyday of such solar power satellites is likely never to come. They will literally not have their "place in the Sun." Nor is it probable that photovoltaic or other conversion of sunlight to electricity will become a primary energy source on Earth's surface—however well-intended these efforts might be.

Terrestrial and space-based solar power are destined to fade, primarily because the power of the Sun has already begun to come down to Earth. Certainly this has not happened in any practical sense at the failed and dying hot fusion reactors at Princeton, MIT, and elsewhere. Rather, the Sun's power

now comes in more concentrated, practical form: low-energy nuclear reactions (LENRs). These mimic on Earth at near ambient temperature what supposedly occurs deep within a stellar interior at (allegedly) multi-millions of degrees. "The circumstances of solid-state cold fusion are not those of hot fusion," to paraphrase the late Nobel laureate Julian Schwinger. LENRs don't deliver lethal radiation, just wonderful, enduring heat.

At least one branch of the expanding field of LENRs appears to be quite literally the *cold fusion* of deuterium (heavy hydrogen) into helium-4 (garden-variety helium), with perhaps a dash of the rare isotope helium-3 being produced as well. That is how Professor Y. Arata and Dr. Y.C. Zhang described their work in the *Journal of the High Temperature Society of Japan*, "Solid State Plasma Fusion ('Cold Fusion')" Vol. 23, the entire 56 page January 1997 issue. These experiments were done electrochemically in heavy water, as was the original Fleischmann-Pons experiment, but in this case a special cathode was used that contained powdered palladium black sealed within a Pd-metal chamber. Respected hot fusion scientist Arata, for one, believes that the power of the Sun has already come down to Earth.

It is coming down for others too. As Jed Rothwell reports in this issue (page 25), Dr. Michael McKubre of SRI International reported to a session of the Annual Meeting of the American Physical Society the results of a straight Pons-Fleischmann cell replication. Helium-4 production was 99% commensurate with the excess heat measured from the SRI experimental cell. That is, it could be explained by the diversion of the normally expected high energy (23.8 MeV gamma) radiation into metal lattice heat. By his nature, McKubre is much more reserved than Arata in touting his work as "cold fusion," but let's face it, he knows what he's got and he has a great suspicion about what it is: the power of the Sun brought to Earth.

Low-Energy Nuclear Reactions were also the subject of several talks at the June 1999 meeting of the Society for Scientific Exploration (SSE) [18th Annual SSE Meeting, Northrup Hall, University of New Mexico, Albuquerque, June 3-5]. There Dr. McKubre reported more

details of his group's replication of the high-temperature catalytic fusion process of Dr. Les Case (see *Infinite Energy* Issues, No. 19 and following). He reported that 50 cubic centimeter closed cells, containing commercial catalyst (Pd-doped carbon), produced apparent excess heat output of roughly 0.25 to 0.5 watts. He had run about a dozen cells, with a success rate in the range of 30% to 50% of the cells. McKubre reported that care must be taken in this work, especially in making sure that the catalysts are pure and clean.

In the pressurized heavy-hydrogen gas, helium-4 appeared to grow roughly linearly with time to about 11 ppm helium-4, exceeding the 5.22 ppm helium-4 in the ambient environment during the month of its operation. There was practically no chance then that the vessel's helium could have come from external infiltration—or, for that matter, from internal contamination. The control run with ordinary hydrogen gas (H₂) produced no unusual effects whatever—no apparent excess heat and no helium. Again, the power of the Sun apparently brought to Earth. McKubre said that the case for the excess heat was "essentially overwhelming."

Dr. Melvin Miles of the U.S. Navy's China Lake Center again reviewed his compendious results for helium association with excess heat production in Fleischmann-Pons-type cells—a clear demonstration of the power of the Sun brought to Earth. His full 1996 U.S. Navy report about this was reprinted in *Infinite Energy*, Issue No. 15/16.

Why then is there not a great ringing of bells, fireworks, and celebrations heralding the coming Cold Fusion Age? The world at large little knows nor apparently has long remembered the promise of cold fusion, which burst forth in March 1989. A sign of this: *Time* magazine dated June 14, 1999 listed Cold Fusion among "The 100 Worst Ideas of the Century." It is right up there with Woody Allen, Prohibition, The Maginot Line, The Titanic, the (fraudulent) Hitler Diaries, and the Jerry Springer Show. With such impunity do the less-than-funny people at *Time* pass judgement on one of the most important discoveries in the history of science. Revolting! Fortunately, the ignorant hacks at *Time*, and their cousins at various science magazines who should know better, will not determine the course of scientific history. Mother Nature is speaking to us loudly and clearly: "Yes, I can do this trick of

bringing the power of the Sun down to Earth—power for you to live and prosper by." It will be done. The question is, "When?"

Should we be so surprised that a very good thing has taken a little more than a decade to get even this far—encouraging reports at obscure meetings by frontier scientists who are mostly ignored or mocked? Look at the history of photovoltaic cells—the conversion of sunlight to useful electricity. According to the excellent history, *From Space to Earth: The Story of Solar Electricity* (John Perlin, 1999, Aatec Publications, Ann Arbor, Michigan), the first hints of the ability of light to generate electricity appeared in the 1860s. A selenium testing device being used to lay trans-Atlantic telegraph cables evidenced the phenomenon. Then in the 1870s in England, Prof. William Grylls Adams and his student Richard Evans Day proved that light, not heat, was the actual source of the electrical power being generated in selenium.

According to Perlin's book, German scientist Werner von Siemens judged the photoelectric effect "scientifically of the most far reaching importance." Ditto for James Clerk Maxwell. Perlin writes: "Few scientists heeded Siemens call because most of his contemporaries viewed photoelectric devices, such as Fritts' 'magic' plates, as perpetual motion machines. They appear to generate power without consuming fuel and without dissipating heat." It took until the 1950s for the more potent but still weak silicon photo-electric cell to be developed. It was not until the energy crunches of the 1970s that more attention was paid to photo-electricity as a utilitarian power source. We hope and trust that it will not require a century for cold fusion power to be commercially developed.

Already there are signs that cold fusion will not suffer the century-long trial of photoelectricity. First, there is more impetus today to find clean, renewable energy sources. There is also the real prospect that the catalytic fusion approach of Dr. Les Case will prove viable. It looks to be a robust process, but, to be sure, it is still having its growing pains. It is wonderful that we now have solid confirmation of the Case process in the SRI results. It is so very tragic that because of the arrogant opponents of cold fusion, these conclusions are not widely known and appreciated.

If some show-stopper for catalytic fusion should arise, e.g. short-time failure of the catalysts, there is another very promising technology now emerging from its present sleep in the hands of CETI (Clean Energy Technologies, Inc.): the thin-film multi-layered cathode electrolytic approach of Prof. George Miley of the University of Illinois at Urbana-Champaign (see *Infinite Energy*, Issue No. 9 and following).

Based on his work with his own (not CETI's) nickel- and palladium-coated

beads in 1996, Dr. Miley's group is now forging ahead with fairly consistent and reproducible heat generation, but with other geometries and techniques. Expect to hear much more from the Miley group soon. CETI may return to the fold if it can iron out the problems that it had been having with reproducibility *on demand* of its thin-metal-film excess heat process.

There is Very Big News on the "political" front from Miley. In early May 1999, Miley's Low Energy Nuclear Reactions Group was awarded a contract by the U.S. Department of Energy to conduct a "Scientific Feasibility Study of Low-Energy Nuclear Reactions (LENRs) for Nuclear Waste Amelioration." Miley's proposal was selected by the DOE's Nuclear Energy Research Initiative (NERI) program as one of forty-five awards, made on May 7, that "resulted from the independent peer-review" of 308 proposals received by the DOE.

This is the very first time since 1989 that the DOE has *officially* spent money on cold fusion research—beyond the initial period in which the DOE's "HeavyWatergate" Huizenga Cold Fusion Panel did its dirty work (which still continues to obstruct the

Editorial continued on page 41

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LETTERS TO THE EDITOR

Keep on Experimenting

I was very interested in the conversation we had on the phone a few weeks ago and I wish to thank you very much for the sample copies of *IE* which you sent to me. One of the copies had an article which answered my question about Brown's Gas. Enclosed is a copy of the article in *Research and Development Magazine* which prompted me to call you. I am surprised at the amount and variety of work currently being done on cold fusion.

In about 1989, I was involved in nuclear research at the U.S. Geological Survey and when news broke about cold fusion, we set up an experiment to duplicate the original University of Utah electrolysis experiment. We ran the experiment for about two weeks, monitoring both the neutron and gamma ray background around the cell. One morning I observed the gamma ray (but not the neutron) background had increased several times its normal value for a period of about twenty minutes. However, we were never able to report this change in background. Subsequently, we were involved in other work and never pursued cold fusion any further. My interest still lingers on, and if I have the opportunity, I would like to try some other experiments.

Again, thank you for the information and perhaps we will have the opportunity to discuss cold fusion in the future.

F. Senftle

The Center for the Study of Terrestrial and
Extraterrestrial Atmospheres
Howard University
Washington, DC



Cold Fusion Bias?

Enclosed is a bank draft to cover a one year subscription. This I do under duress, and this will be my last subscription if your magazine must year in and year out publish more material on cold fusion than all other technologies known in the field of new energy applications.

There is no denying the magazine is biased in favor of cold fusion efforts, with scant regard for other known, cleaner new energy devices.

Your reminders and advertisements are, too, all cold fusion-oriented.

Robert Adams

Kawaray, New Zealand

Dr. Mallove's Response:

We received your letter, in which you expressed disappointment that much of what we cover in *Infinite Energy* is on cold

fusion. You feel we are excluding what you believe to be many other technologies in the new energy field.

Please let me respond briefly to your complaint. First, I appreciate that you have let us publish your work in the past. Second, there is no deliberate plan to publish "cold fusion material only." You may disagree with the percentage of focus, but cold fusion is the field from which our interest in this area began. It is also, in our view, the area in which the most accurate and convincing measurements have been made over a breadth of systems—energy measurements as well as nuclear changes. We wish that there were an equivalent quantity of measurement data to support magnetic motor performance. Regrettably, there is not—at least that is our view. That may change in the future.

We hope that you will feel free to bring to our attention any information that you deem worthy of publication in the new energy field, particularly convincing measurements of over-unity electromagnetic systems or any anomalies thereof. And, we certainly hope that you will remain as a subscriber for a long time.

Best wishes,

Dr. Eugene F. Mallove



Defending CSICOP

Editor-in-Chief Eugene Mallove's article in your January/February (No. 23) issue demonstrates that he himself is guilty of that of which he accuses CSICOP. Mallove charges that articles in CSICOP's *Skeptical Inquirer* are "hatchet jobs by individuals bent on dismissing all evidence based on 'this cannot be' paradigms, rather than on objective examination of the evidence." Mallove then cites me to support his claim: "For example, the cavalier, arrogant rejection by Philip J. Klass of the entire body of UFO evidence."

If Mallove had made an "objective examination of the evidence," he would know that I have spent many thousands of hours during the last thirty-three years investigating the best, seemingly most inexplicable UFO cases. If I had found even a single case that defied prosaic explanation, I would have rushed to my typewriter (now my PC) to write the most exciting story ever published by *Aviation Week & Space Technology* magazine. (For thirty-four years I was one of that magazine's senior editors and since my "active retirement" in 1986, I've been a contributing editor.)

I challenge Mallove to cite one instance in any of my *Skeptical Inquirer* articles or

in one of my six books on UFO's—dating back nearly a third of a century—where I resorted to a "this cannot be paradigm."

Philip J. Klass
Washington, DC

Dr. Mallove's Response:

Philip J. Klass claims that he does not "reject the entire body of UFO evidence." I disagree. Though Klass has produced large numbers of reports, books, and CSICOP-issued press releases claiming to debunk various UFO sightings, his work often does not pass some elementary tests of scientific credibility.

I am not an expert on UFO case investigations, but I am sufficiently familiar with the field to understand the basic methodologies. Mr. Klass is famous for proposing "explanations" for unidentified sightings that patently do not fit the facts of a particular case. With a physicist whose work in the UFO investigation field I do respect, Dr. Bruce Maccabee, I recently reviewed some of Klass's proposed explanations for several important UFO sightings. These Klassian explanations did not, in Maccabee's view, or in my view, hold water. For a conventional explanation of a particular UFO sighting to be trusted, it must realistically fit the data of the case.

Positing prosaic explanations that simply do not fit a given case well at all is not an adequate dismissal. Consequently, I conclude that Klass will in every difficult-to-explain UFO case reach for a very tenuous (or patently erroneous) conventional explanation, rather than accept that the sighting is really unexplained—and *might* be something of great scientific interest. Klass uses a similar kind of false logic that the critics of cold fusion have employed to dismiss evidence of low energy nuclear reactions: "It can't be true or is unlikely on theoretical grounds, therefore the claim has to be incompetence, misinterpretation, or fraud." Mr. Klass may not *explicitly* use the "this cannot be paradigm" as his operating philosophy, but *in practice* it seems to be. The "Klass-dismissed method" is not helpful in getting to the bottom of the UFO enigma.

It is heartening that Mr. Klass, now a contributing editor for *Aviation Week*, has become a subscriber to *Infinite Energy*. We hope that he soon does "rush to his typewriter" to tell his audience of *Aviation Week* engineers and business people that thanks to the evidence developed in the low-energy nuclear reaction field, abundant, clean space-nuclear power may become a reality in the foreseeable future.—EFM



Y2K Conundrum

Please tell Mr. Clarke to stop his specious comments about the beginning of the millennium. His entire argument hinges on a very thin mathematical concept that there was no "year zero." There was a "year zero"—it was the year immediately before year 1. It may not have been labeled or called "year zero," but it existed and when the calendar rolls over from 1999 to 2000 it will be the start of the third millennium.

When a car odometer rolls over to 100,000 we say it has one hundred thousand miles on it—not when it hits 100,001. In addition the Y2K problems and ALL the parties will be on or about 12/31/1999—not a year later.

His comments detract from his otherwise notable achievements.

Peter E. Haynes
Bayport, New York

Arthur C. Clarke Responds:

Of course 100,000 on the odometer represents one hundred thousand miles—because it starts at zero, not one. But our calendar started at 01/01/01, not 01/01/00! QED. . .

It's amazing how many people have fallen into this trap, so Peter Haynes needn't feel too foolish. . . I always ask them: "Would you be happy to buy ten pounds of sugar from a grocer whose scales registered one when empty?"

If Mr. Haynes wants to disagree with my friends the Astronomer Royal and the Director of the Vatican Observatory, as well as the U.K. Government's Millennium Committee (which published an annoyed memo a year ago asking cranks not to continue wasting time arguing for 2000), that's his problem, not mine.

And here's an interesting historical footnote. The opening of THIS century was celebrated at the correct date, January 1, 1901, and there was apparently no 1900 nonsense. Does this mean that standards of intelligence have since declined? One could make a very good case for this from other evidence; just switch on your TV.

However, we should certainly celebrate 2000, as it IS a numerical, if not calendrical, millennium of great psychological importance. The Astronomer Royal suggested to me that it will give an excuse for a whole year of partying. Unfortunately, the dreaded Y2K bug means that many people will greet those three zeroes in darkness, to the sound of police and fire sirens. . .

All the best,
Arthur C. Clarke
Sri Lanka



Circuit Element Anomalies

I would like to submit an idea about cold fusion for your consideration and that of your readers. I make no property claims over this idea and offer it for unrestricted use by any and all interested parties. However, should my observation lead to resolution of the experimental replication difficulties surrounding cold fusion, I would ask for appropriate intellectual credit.

Engineers, hobbyists, and experimenters in the field of audio electronics have become aware over the last twenty years or so of circuit element anomalies that cause very small (and immeasurable) differences in output waveforms. The anomalies are so small or unusual that they can only be detected psycho-acoustically.

Examples are: detailing within stereophonic images, instrumental harmonic rightness, noise floor perception, etc. The high-end audio electronics industry has never been able to contrive measurements that can describe or account for these perceptual nuances. However, trial and error has suggested some causes: 1) diode effects of mechanical switching surfaces and other types of connections; 2) capacitor construction and, especially, surface material; 3) resistor construction and materials; 4) thickness and coating of printed circuit boards; 5) mechanical resonance behavior of the equipment chassis; 6) conductor material; 7) insulation material; 8) proximity to other electronic devices; 9) quality of AC supply current from the utility and 10) other electric or electronic equipment operating, even at a distance, on the same circuit breaker or even on the same transformer drop. There are undoubtedly other causes as well; these are the ones most often discussed in the underground audio press.

Traditional electrical engineering does not recognize any of these effects. However, I believe that cold fusion test set-ups may be influenced by them. Specifically, I suspect that some set-ups succeed because fusion is being initiated by spuriae originating coincidentally in the batteries, power supplies, wires, or connections used for the electrolysis. I would especially suspect dioding caused by switches or battery clips. This would produce small AC waveforms superimposed on a DC potential.

Are cold fusion experiments controlled or monitored for power supply differences?

It is critical to appreciate that I am not talking about supplying the electrolysis with square waves, spikes, sine wave currents, etc. (I believe these have already been tried unsuccessfully.) I am talking about a very minute, unidentified (as yet) signal voltage getting into the set-up coin-

cidentally and triggering unusual heat production via an unknown process, which, at present, is presumed to be nuclear fusion.

Like the rest of us, I was amazed and elated by Pons and Fleischmann's announcement, then angered when the scientific debate degenerated into a hornet's nest over professional manners. I hope my motion proves useful.

Charles H. Wheeler
Patterson, New York



Thanks to IE

I wish to express my heartfelt thanks for your dedication to scientific truth and your efforts to inform the world about one of the most important discoveries of all time. If not for your efforts, even before *Infinite Energy*, I would not have been able to mount my in-depth study of this remarkable science. For that I will always be grateful.

I, and many of my fellow science buffs, wish you only the best for the years to come. Thank you for a job well done and best wishes for the future.

Neil R. McCanney
Tampa, Florida



. . .No Failures, Only Delays

Film star and environmentalist Dennis Weaver is an ally of New Energy research, referring to it in his writings as space energy. He founded the Institute of Ecolonomics, and several colleges have added a School of Ecolonomics to their curricula because of his push to bring ecology and economics together (www.ecolonomics.org).

In Weaver's recent newsletter is an article titled "Ecolonomists Can't Be Wimps" by John McKenzie, president of Natural Chemical Technologies. It's relevant to New Energy struggles because McKenzie says he wants to show how idealism can clash with reality, and how even having a revolutionary product doesn't mean the situation will improve immediately.

His company was invited by a major banana producer in Central America to consult on the problem of fungus on bananas. In one plantation alone, \$5 million a year went to synthetic fungicides and their use was escalating, resulting in high levels of chemical residue on the food. McKenzie's company developed a solution which would reduce chemical use by sixty percent and save \$2 million a year for the plantation.

McKenzie's company put its energy into planning for increase in production

"and since none of us has drawn a salary in years (New Energy researchers can relate), we actually started anticipating a paycheck. But then beautiful idealism met ugly reality."

The U.S. firm that sells all that fungicide got wind of the innovation "and although we can't prove it, they apparently read our report." The fungicide firm told the client that their price was being cut by fifty percent immediately and the client would get a free research team to study ways to reduce residues in the bananas.

McKenzie's natural pest-repeller lost the contract, but he philosophically says, "If only because our losses keep getting more spectacular—it's taking bigger and bigger guns to hold us back—we're pretty sure we must be getting close to a major victory."

He advises other "ecologicomic entrepreneurs" to expect opposition from the status quo "even as you commit to stay the course despite it. . .there are no failures, only delays."

Take heart, even if gas prices decimate when we get low-cost alternative propulsion onto the market.

Jeane Manning
Kelowna, Canada



Editor's Note on Dr. Ruggero Santilli's Series of Articles

It was our great privilege to have published in three recent issues of *Infinite Energy* (Nos. 22, 23, and 25) the pioneering scientific articles by Dr. R. Santilli of The Institute for Basic Research. On May 31, 1999, William Pound of the Institute for Basic Research, a colleague of Dr. Santilli, notified *Infinite Energy* in writing that he believed another scientist, Dr. Elio Conte, had plagiarized Santilli's theoretical work on the pages of *Infinite Energy* in Issue #24. We quickly notified Dr. Santilli and Mr. Pound of our intention to employ outside reviewers to determine the validity of Dr. Santilli's accusations and to publish a report when completed. (Curiously, Issue No. 24 had been in the hands of Dr. Santilli and Pound since approximately March 21, 1999—for almost two months. The delayed discovery of alleged plagiarism occurred apparently at the time that Santilli became angry about a letter by Mr. Ken Rau in Issue No. 25 in which both Santilli and the allegedly offending scientist were taken to task for their earlier published squabbles about proper citation—see exchange of letters, Conte vs. Santilli, in No. 24.)

We had every intention, at the time of the Santilli-Pound plagiarism accusation, of continuing to publish Dr. Santilli's series, specifically section III-B was to have appeared in this issue (No. 26). We had already edited this material in preparation for publication. Dr. Santilli became enraged that we were not able to publish the Pound-Santilli multi-page denunciation of Dr. Conte in this current issue before we had even finished our investigation of their charges. Dr. Santilli claimed that it was so self-evident that a plagiarism occurred that one did not have to be a physicist to determine this and, therefore, his denunciation of Dr. Conte should be published immediately in this present issue No. 26. We disagreed then and still do. An investigation of the entire matter is underway.

We note that on May 31, Pound-Santilli strongly suggested that Dr. Conte not be given the opportunity to view the charges against him for rebuttal in the issue in which the denunciation would appear. This is the specific text:

"(3) You abstain from sending my condemnation to Conte for his comments. If you instead elect to send it to him, you will suffer additional credibility damage. In the pursuit of an illusory democracy, you will end up publishing manifest trash, lies and junk science as that in Conte's replay [sic] to Ruggero, such as the lie that don [sic] Borghi and his team did not look for the cold fusion of protons and electron into neutrons, or the ridiculous statment [sic] that Ruggero condemned Conte because he is envious of him (!!!),

and other statements so manifestly false that can only cause additional damage to you and to your important journal."

Subsequently, on June 9, we received a fax from Dr. Santilli in which he formally withdrew the remainder of the series of technical articles. We accepted this withdrawal with regret, based on a continuing series of preposterous legal threats against this magazine and staff by Dr. Santilli. These threats have now (June 29, 1999) escalated to this intemperate warning:

"If I receive no notification from you ON OR BEFORE JULY 7, 1999, you are hereby formally notified that I shall assume that you persists [sic] in your illegal and profoundly immoral stand of stubbornly refusing rapid corrections for a serious editorial tort, and I shall feel free to file a law suit [sic] from July 8, 1999, on [sic] without any waiting for your next issue. Moreover, once filed, the law suit will stand even to the eventualty that you subsequently publish our denunciation. . ."

We at *Infinite Energy* are most distressed by these threats, particularly in view of what we had considered our earnest and difficult efforts to publish a series of highly technical articles by Dr. Santilli. Annoying as these threats are, we are certain that we have done nothing unethical or illegal in this matter. Therefore, Santilli is wasting his and our time. In Issue No. 27 or No. 28 we will publish whatever our investigation determines regarding the Santilli-Pound accusations against Dr. Conte. Dr. Conte will have the opportunity to reply. We have asked Dr. Santilli to let us know in which journal he will publish the continuation of his series of articles so that we may tell *Infinite Energy* readers where they may find these articles.

—Dr. Eugene Mallove, Editor-in-Chief

Hours before this issue went to press, we received the following e-mail message from William Pound: "July 8, 1999 I hereby withdraw my denunciation of Conte's plagiarism submitted on May 31, 1999. William F. Pound"

This may modify our future coverage of Dr. Santilli's accusations. —EFM

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Taxpayers are conditioned to think of "research" as what is done in universities by people with government grants. Actually, research is what was done by the Wright brothers with their own money.

Dr. Thomas E. Phipps, Jr.

This is the era of "extreme" this and "extreme" that. One need only turn on the TV to find shows about "extreme machines" and "extreme sports." You need only channel surf through MTV once to find clear evidence of both extreme behavior and extreme fashion amongst our youth. The trend you see is a desire to push everything to the limits.

With this in mind, one might think that something called "extreme physics" would, naturally, deal with physics at the extremes—work done at extreme temperatures, either hot or cold; work done at extreme pressures; or perhaps work done at the extreme edge of known physics.

Yet this is not what I have in mind when I talk of extreme physics.

We can do better than that at *Infinite Energy Magazine*.

Extreme physics deals with physics from **beyond** the cutting edge. Cutting edge physics is approached from the realm of the known, but extreme physics approaches the cutting edge from the direction of the unknown. We do well when we remember the words of Arthur C. Clarke: "The only way of finding the limits of the possible is by going beyond them, into the impossible."

But the impossible is a pretty big place. And we aren't really talking about *the* impossible, but about that which is *perceived to be* impossible. *Infinite Energy Magazine* exists as a showplace for those trying to distinguish between the two. This is a knotty problem. Indeed, some things that apparently *are* impossible, like commercially viable hot fusion using tokamaks, are still, in some quarters, not perceived as such. Yet other things, some that are now demonstrated to be real, like "cold fusion" (I use the quotes here to distinguish between observation and explanation), are thought to be impossible. It is even the case that some concepts, common dogma only a century ago, like aether detection, now lie in the realm of things

considered impossible.

The knottiness of the problem makes heavy demands on the would-be extreme physicist. He or she must spend a great deal of time in the library. It is not enough to know what one mundane physicist says is impossible—he can be mistaken. It turns out that even what is considered "known" in academia today is a slippery subject. Try reading the literature on unipolar induction (my own work with the Marinov Motor involves this effect—I think) if you have doubts about that. Sommerfeld says the literature on this subject "is voluminous and by no means free of contradictions" [*Electrodynamics* by Arnold Sommerfeld, pg. 288]. A little library work demonstrates how right he was.

But after enough looking you get a pretty good idea of what is considered true and what isn't. The next demand made on the extreme physicist is that he must apply *absolutely* honestly the scientific method while investigating the impossible idea or the impossible effect.

In lazy science circles, science consists of finding that explanation which looks the most conventional. In a bastardization of Occam's razor, it is accepted *a priori* that the right answer is the one that will require the least stress to the status quo. Subsequently, this explanation is to be preferred no matter how unlikely the chain of conventional circumstances must be to maintain the status quo. This approach is every bit as antithetical to the pursuit of truth as the demand by some cranks that the "true" answer *must* be something completely new that no one else has ever heard about.

By honesty, I don't mean refraining from deceit. That's a given. I mean that the extreme physicist must be willing to look as closely and objectively at his work as he can. He must discover to the best of his ability what it is that accepted science says can happen in the experiment he is conducting.

He must describe with exquisite care and precision *exactly* what it is his experiment is doing. He must never allow familiarity with his work to give way to complacency.

I was burned by complacency in my own work.

As I've related before in several articles about the Marinov Motor [IE Nos. 17, 18, 19, and 20], I and others assumed that, whatever the effect was that was happening between the ring and the magnetic torus, it most certainly *was* happening between the ring and the torus. Furthermore, we were certain that the effect must certainly obey something as fundamental as Newton's Third Law. In other words, we were sure that a counter-clockwise accelerating torus must be indicating that the ring was feeling a force trying to cause it to rotate in the clockwise sense.

I had rotated rings and this assumption seemed warranted. Indeed, I didn't even think of it as an assumption. Others and I had built motors with rotating toruses, some capable of a thousand RPM. Nothing indicated to us that anything was amiss in our thinking.

And then one night when I had a ring rotating superbly, I altered something that "couldn't possibly make a difference" to my results. Yet it did. And the next day, despite recognizing the "impossibility" of what I was doing, I made the ring and the torus rotate in the same direction.

The learning curve got a lot steeper at that point.

When exploring beyond the cutting edge, you're in dangerous territory. There are mountains out there to climb, of course, but no paradigmatic fences to keep you out of danger. You're often alone, too. For although others are out there with you, there are many mountains in that place, and each explorer has his own to climb.

But if you do happen upon a fellow explorer, offer him a helping hand.

And don't be afraid to take his either.

□□□

COFE: A Largely Personal Account

by Jeffery D. Kooistra

Photos by Ed Wall and Jeffery D. Kooistra

The First International Conference on Future Energy (COFE) was held over three days, April 29-May 1, 1999, at a Holiday Inn in Bethesda, Maryland. It was supposed to have been held at the U.S. State Department, but then was booted out via the machinations of one Dr. Peter Zimmerman, an action he bragged about at the recent APS Annual Meeting in Atlanta, Georgia [see account in *IE* No. 25]. The Conference temporarily found a new home at the U.S. Commerce Department, but Zimmerman's wave making got it canceled there, too.

Despite these childish attempts at ruining the meeting, I'm happy to say that COFE was exceptionally well-run and well-attended (some 180 people registered).

Wednesday evening, April 28, there was a cozy wine and cheese reception, then things got rolling Thursday morning. One of the first people I noticed in the audience was a stick-figure of a man who turned out to be none other than Dr. Robert



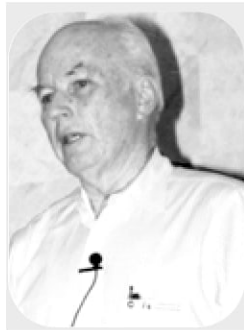
Dr. Robert Park

L. Park, Supreme Inquisitor of cold fusion, "extreme physics," and the practitioners thereof. He seemed a bit high-strung, but I guess that's to be expected when visiting a conference attended by scientists one has denigrated in print. He stood in the back of the room, seemingly distancing himself from the audience of improper scientists, jotting no doubt "damning" notes as occasions arose.

Thomas Valone, president of the Washington, DC area Integrity Research Institute (which was running the show, with a significant financial assist from *Infinite Energy*, thanks to a benefactor) opened the conference. He asked us to raise our hands if we wanted free energy, which we all did, even Dr. Park. Later, Park made fun of this in his "What's New" column. Park also seemed to like free coffee.

The first speaker was Ken Shoulders of Somerset Power Corporation, speaking on "Charge Clusters in Action." He talked extensively about a sidelight to his main work, that sidelight being the physics of charge clusters. Charge clusters, or "EVs," as Shoulders calls them, are nifty little buggers, huge numbers of electrons that move herd-like through space, and which are surprisingly easy to generate with simple spark-making equipment. He presented a large selection of slides that showed the kinds of holes that EVs bore through materials such as ceramics. Of great interest was the nature of the material spewed from these holes by the EVs. It looks as though EVs don't melt the material, but rather disassociate it, for there is evidence of sloshing, yet no evidence that the material ever gets very hot.

Shoulders also described various



Ken Shoulders

energy aspects of the EVs that make it look like these are genuine over-unity phenomena. Comparing the amount of energy one puts in to make an EV, which is next to nothing, with the significant amount of energy that must be there for an EV to do what it does once it is created, simply leaves one baffled. Far from keeping these delightful mysteries of nature to himself, Shoulders practically begged us to investigate EVs for ourselves. During this talk, I noticed that Dr. Park was scribbling notes. I wondered if he was planning to do some of that investigation? (Wink.)

Next came Dr. Paul M. Brown of Nuclear Solutions, LLC, who talked about "Betavoltaic Batteries." These are nuclear batteries that convert energy from a beta source, such as tritium, into electrical power. Dr. Brown's talk was lucid and intriguing, until he



Dr. Paul Brown and Dr. Eugene Mallove

got to the theory part, which reflected some confusion about just what energy it is that's being converted. One battery described has as its source of power a strontium-90 sample, good for about 30 milliwatts of output as reckoned by the kinetic energy of the beta particle (electron) emissions.

However, the battery itself, which employs passive components, puts out 75 watts of AC electrical power. Brown's explanation accounts for this "extra energy" by suggesting that not only is the emission energy from the nuclear expulsion of beta particles reclaimed, but also the magnetic field energy associated with the moving charged particle. But in conventional analysis, the emission energy is supposed to include the field energy, so the 30-milliwatt figure given for the radioactive source is supposed to be the whole shebang, kinetic energy and field energy combined. (This battery has been described in *IE* No. 13/14, pp. 52-53.)

In Dr. Brown's defense, particle physicists talking about accelerator and beam physics seem to get in a muddle on these issues too. Brown didn't invent nuclear physics, nor the energy accounting methods; he can only go by what the books say. And what the books say is that there's no way he should be able to get 75 watts out of a 30-milliwatt source. Let's just say I'll take the power meter over the book any day.

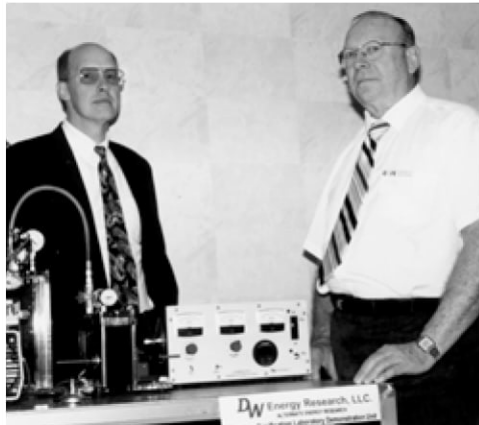
I think having Brown speak after Shoulders helped highlight the weird nature of electrons (and positrons). With both speakers we see that over-unity phenomena may be produced readily if we accept that these experimental results are bona fide.

Sometime early in Dr. Brown's talk, Dr. Park left the meeting. I noticed him watching Brown at the beginning, but shortly after the talk began, I saw that he'd left his seat. I know that our photographer on the scene, Ed Wall, asked Dr. Park to be photographed in the open area outside the conference room. Park said that he wasn't too fond of the photo of him that we had

been using in *Infinite Energy*, but then he excused himself to the bathroom (blame that free coffee). After that, Park proved as hard to find as the elusive Dark Matter (hot, cold, or tepid).

Following Brown, Kent Robertson of the American Wind Energy Association spoke about "The Coming Energy Revolution from Wind." The talk made a strong case for the present economic feasibility of wind power generation on shared-use land, such as agricultural areas. We wish this fine effort well, but sincerely hope that progress on other free and future energy systems will eventually make windmills obsolete.

After lunch the conference continued with a talk by David Wallman and Wilbur Dammann of DW-Research on "Carbon-arc Gasification of Biomass Solutions." They provided an excellent overview of their activities in generating Carbo-Hydrogen™ gas in a prototype laboratory test device, which *Infinite*



David Wallman and Wilbur Dammann

Energy has profiled in several past issues. They demonstrated their high-quality unit for all to see.

After Wallman and Dammann, Dr. Peter Graneau (Northeastern University Center for Electromagnetic Research), who swapped time slots with Paul Pantone, spoke. Graneau looked every inch the kind of man who makes his living zapping high-voltage sparks. He spoke about the arc-generated "Release of Chemical Bond Energy," which sounds mundane, but was not. *Infinite Energy* has reported on this important work in several issues past: *IE* No. 10, p. 59; *IE* No. 13/14, p. 92; and *IE* No. 25, p. 9. Using high voltage, high current discharges of electricity through water, Graneau is able to liberate much more energy than goes into the spark itself. This was both one of the most interesting talks at the conference, and one of the easiest to understand. The new physics revealed by this process cuts right to the heart of where electrodynamics theory has stumbled. The core difficulty of the Graneau work for establishment physics starts with the spark itself. Normal electrodynamic "pinch forces" are orders of magnitude too small to rip water molecules apart at the power levels used in this work. Even to take the water apart as happens in this process requires longitudinal Ampere forces, which are largely unknown to conventional physics, though they were familiar in the last century. After the water is zapped, a plume of cold fog is produced—cold, yet potent enough to blast that plume to supersonic velocities. Much of Graneau's talk concerned the meticulous ways in which energy accounting was done. The bottom line is this: for every 100 joules put into the device (most of which is loss—it doesn't go into breaking up the water), 150 joules of energy comes out.

Whence cometh the excess energy? According to Graneau, it comes from the water molecules themselves. There is a binding energy associated with water molecules and, basically, the latent heat of vaporization is different for fog droplets than for bulk water. So zapping the bulk water into fog leaves a bunch of excess energy available to blow the water droplets apart quite spectacularly.

Let me highlight some similarities with previous talks.



Dr. Peter Graneau

Recall that Shoulders uses EVs to disassociate matter, and finds that it remains cold. His EVs are, he believes, clusters of electrons. He sees over-unity effects. Dr. Brown has a process, involving Beta particles (i.e. electrons), which also produce a huge over-unity effect (though for now he'd like to believe he can take care of this by changing the energy accounting process). Dr. Graneau has a process, again involving electrons, and he also finds over-unity effects. Always the conservative physicist, Graneau thinks that the excess energy comes directly from intermolecular bonding energy. These three scientists have enough work to do already, so I think some of us should start to investigate these processes with the specific intent of sorting out the similarities.

Paul Pantone of Global Environmental Energy Technology (GEET) followed Graneau. He discussed his "Plasma Fuel Processor" and he spent time talking about his GEET technology, which



Paul Pantone

he neglected to define. This isn't entirely a criticism. I had not heard Pantone speak before and I wanted to get a sense of this dynamic personality—a new energy pioneer whose forté is actually selling (and delivering) real devices to the general public.

He described a type of modification his company makes to existing engines that: 1) allows them to burn almost anything with carbon in it (mixtures of gasoline, diesel fuel, and Mountain Dew beverage are not uncommon) and, 2) allows these exotic fuels to burn very, very cleanly.

I heard one participant say that Paul sounded like a "snake oil salesman." Yes, he did, but I had the advantage of knowing that we actually have a few of Pantone's modified engines in our lab; they most certainly will burn unusual mixtures as fuel and, yes, they do seem to burn very, very cleanly. Unlike some "researchers" in the New Energy field, Pantone has an actual product, not a promise of a product, and he does allow people to test it. He even started up an engine for us, running on a deadly (for the engine) mix of gasoline and fuel oil. This demonstration was met with mixed reviews, since the audience was in an enclosed room in a hotel. Though there was a significant smell, which I'm told is typical when first starting up the modified engines, it certainly seemed as pollution-free as the inventor claimed.

The final talk of day one was delivered by Integrity Research Institute President himself, Thomas Valone. However, since his talk dealt with the material that is covered in his article, "Inside Zero Point Energy," which appears in this issue of *Infinite Energy* (pp. 53-57), it is best you go there and read about it in his own words.

After a day of speakers, the audience left to fuel up on fine food, a rather trivial exercise, because near the hotel good restaurants were plentiful, including an Italian cuisine place named "Frascati"—interestingly the namesake of the location of an ICCF-8 (May 2000) sponsor! Early that evening many returned for the first Washington, DC area public showing of the video documentary "Cold Fusion: Fire from Water." Narrated by James "Scotty" Doohan, of "Star Trek" fame, this video is the first to put ten years

Doohan, of "Star Trek" fame, this video is the first to put ten years of cold fusion research into full perspective, and to clear up the many misconceptions that remain from the past. It was very well-received. Granted, the audience was predisposed toward acceptance, but it didn't need to be—the video is *that* good. Producer and Director Christopher Toussaint introduced the film, and Dr. Mallove, who with Jed Rothwell helped write the script, participated in a question and answer session after the showing.

The next day began with some confusion. Tom Valone opened the session by telling the audience that yet again we



Tom Valone

seemed to have been victimized by the government, since neither of our speakers from the DOE had arrived, and we didn't know why. Fortunately, this turned out not to be the case after all. Our original opening speaker for the day, Dr. David Goodwin, did appear later, and the other person from the DOE, a personable engineer, David Hamilton, was, in fact, present. Though pressed into service on short notice, Hamilton discussed some of his work at the DOE dealing with electric vehicle studies. He expressed the hope

that some of what he was learning at COFE could be applied to vehicle programs at DOE (see his letter, p. 52).

It turns out that Mr. Hamilton had kindly arranged for COFE to be held at the DOE main headquarters—after the meeting had been booted out of the State Department by Peter Zimmerman. Hamilton had apparently been unaware of the very nasty politics against cold fusion and new energy at DOE, which he encountered when he was told via the chain of command that the meeting was not to occur at DOE and should be canceled. It was. [Editor's note: *Infinite Energy* has learned from reliable sources that the person who requested the COFE cancellation at DOE was Dr. Ernie Moniz, Deputy Secretary of Energy, formerly the head of the MIT Department of Physics.]



David Hamilton of DOE

Some may think that electric vehicle studies are rather prosaic, given the nature of the conference, but this was not the case. Hamilton's talk gave us a rich appreciation for the sorts

of things engineers have to consider when designing a vehicle, particularly a new kind of powered vehicle. A great deal of work that goes into an electrical vehicle is power-supply-independent. Hence, much of Hamilton's work is necessary, whether or not the vehicle is powered by fuel cells or by a Back-to-the-Future-esque "Mr. Fusion" device.

Following Hamilton came Bruce Perreault, who hails from a



Bruce Perreault

northerly portion of New Hampshire. He delivered a sincere but somewhat disjointed talk on his various experiments. He made large but not very clear claims, so I'll leave it to his website to explain whatever the reader of this review might wish to know about Bruce's work [<http://www.cyberportal.net/nuenergy/main.html>].

James Griggs, the inventor of the HydroSonic Pump™, who was supposed to deliver a talk at COFE, did not arrive due to pressing business matters. We have been informed that Jim Griggs is no longer affiliated with HydroDynamics of Rome, Georgia. That company continues to market the device for its mundane (non-over-unity) characteristics and applications.

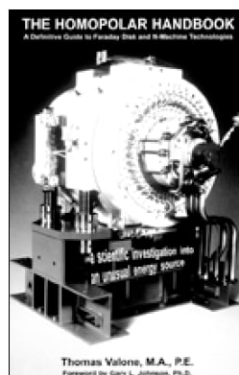
Dr. Steven Greer was the next featured speaker. He is an emergency medicine physician, best known for his work in the field of UFO investigation. He is the founder of the CSETI group. He addressed the topic, "Evidence of Free Energy Suppression." There was some controversy about his speaking at the conference because of his UFO connection. Although, I think there is no doubt that the Free Energy field would do best if it stayed away from most of the "flying saucer" controversy—that's a bottomless pit—still, there are a few select issues where free energy work and UFO studies may overlap. Clearly, if there is such a thing as "free energy" and if 1) purported aliens are visiting us in ultra-high technology craft, or 2) our own "black" programs are producing such high-tech craft (whether or not the "black" programs "reverse-engineered" purported crashed flying saucers to get that technology hardly matters), then we're all stomping around on the same ground.

This should be easy to understand. There is only one Physics; that is, one real set of physical principles that describes the Universe. Aliens would be using that same physics; those purportedly visiting us would have figured out the secrets of free energy, since it's becoming clear already that some of those

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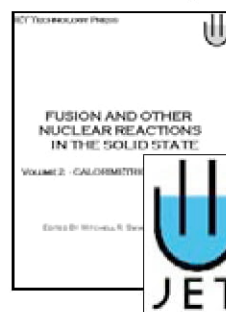
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since it's becoming clear already that some of those secrets can be worked out in one's own workshop.



Dr. Steven Greer

Greer contends that the Earth has been and continues to be visited by extraterrestrials, but they were not his primary concern. If the aliens wanted to harm us, they could drop a big asteroid on us and that would finish off our side of the argument. Rather, he offered us insight into how the secret world of the "deep black" works, and how the "military-industrial complex," about which Eisenhower warned us, came to be and what it knows. It is important to note, Greer said, that these programs are not

really part of the government we elect. In short, the programs exist and go on, and though the U.S. President might know about them, he can't get his hands into them either. Workers in these programs already know how to make free energy devices, "anti-gravity" craft, and the like.

But this is a divided group, these outside the government folks. According to Greer, perhaps 60% want to keep all the secrets, while 40% want to let out some of the information, particularly free energy aspects that would help clean up the planet and remove at least some of the incentives for war. Greer was plain spoken and direct. He explained that if you want to get your free-energy device to market, there are certain ways you have to go about it.

Although his talk was controversial, it was also well-attended and stirred much discussion. At a conference like this it wasn't difficult to find people with stories that suggest the existence of behind-the-scenes interests—stories of seizures of property and harassment related to experimental work. It also wasn't hard to find former military people who had heard and seen things that they were encouraged to forget.

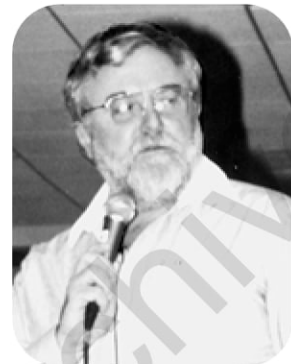
The first post-lunch speaker on Friday was Les Adam of AZ Industries, who spoke on the topic of "Magnet Power and Non-Combustive Helicopters." This accomplished entrepreneur and industrialist spoke about a wide range of activities that he has had in the alternative energy field—mainly well-accepted renewable energy technologies. Among other initiatives, AZ Industries has become one of the foremost manufacturers of specially designed shaped magnets. The company is interested in pursuing magnetically levitated trains. It has a facility in which it archives alternative energy and new energy reference materials. Les' fascinating talk and videotape about power from hydrogen peroxide left me thinking about how soon I might be able to afford one of these small, very simple and inexpensive helicopters. The power-to-weight ratio for the engine, if it can be called that, is greater than anything I have seen, with a couple of drawbacks: the quantity of hydrogen peroxide that must be carried was considerable and hydrogen peroxide is unstable, particularly at warm temperatures (how it compares to conventional fuels, I cannot say). He is an energetic, practical innovator, not afraid to develop new and useful inventions.



Dr. Edward Storms

Ed Storms, of LANL (retired), next spoke on the problems of generating excess energy in palladium-heavy water systems. This materials-oriented presentation followed many of his earlier papers, some of which have been published in *Infinite Energy*, notably one in the Cold Fusion 10th Anniversary Issue No. 24. One point Storms made that bears repeating: the process of "peer review" is actually much more rigorous at LANL than it is in the academic world.

In the slot assigned to James Griggs, who, as mentioned above, couldn't make it, we had David Goodwin of the U.S. DOE Office of High Energy and Nuclear Physics, he having finally arrived. He commenced with his talk on the "Summary of the Breakthrough Physics Conference." Goodwin's talk covered a variety of topics, all of them related to how "breakthrough physics" could help with space travel. The biggest single problem for space travel is, of course, energy. Given enough energy, any kind of rocket can work. Eject mass out the back fast enough and the Solar System



Dr. David Goodwin of DOE

certainly is ours, so a free energy solution for power on Earth could easily be a solution for space travel, too. And the Conference wasn't against looking into wild ideas, such as Faster-than-Light travel and other exotic things.

Goodwin covered issues and ideas in Zero Point Energy, but during this portion some controversy from the floor ensued. Our resident reporter skeptic, Marc Gubrud (who, unlike Dr. Park, did stay for both days and even the banquet), objected to Goodwin using the term "breakthrough" when discussing zero-point theories, since the entire idea of getting useful power out of the zero-point field was, to him, "fringe physics." The skeptic became a bit obnoxious at this point, clearly forgetting that no one had paid

money to hear him speak. At least one person in the audience (OK, it was me) made a rude, though entirely pertinent remark, which broke up the skeptic's discourse. As it turns out, the skeptic's remarks were not off target—zero-point discussions are considered fringe, even though papers on this subject appear often in the usual Establishment journals. This brings up an important point—most physicists don't have any more intelligent opinion on zero-point energy than the average person on the street. They have not studied the issue. So when one says,

"Most physicists would object," this need not mean any more than saying, "Most barbers would object."

I might add that this skeptic's behavior came as close as anyone at the meeting ever got to being disruptive, and yet this was more or less nothing. Had Dr. Park behaved the same way, he would not have been escorted out by security. He might have been verbally disassociated by many of us with the efficiency of one of Shoulders' EVs, but he would not



Mark Whitford

of Shoulders' EVs, but he would not have been ejected. I say this because a colleague of Dr. Park apparently made a great fuss and complaint to one of the staff, Mark Whitford. This after Whitford politely told Park and his friend that no one should feel uncomfortable at the conference, because security was being provided. Park's professor friend apparently took this as a threat!

Finally, a genuine matter of gravity.

The concluding speaker of the day was astronomer Dr. Tom Van Flandern of the Meta Research Institute, who spoke on "A Complete Gravity Model and Free Energy." Van Flandern's background is in astrodynamics and celestial mechanics; he was formerly with the U.S. Naval Observatory. His interpretation of astronomical data (from binary pulsars, planetary dynamics, etc.) is that the speed of gravitational interaction is much, much faster than light, at least several billion times as fast. This may be a surprise to those who think the speed of gravity is the same as the speed of light, but, in fact, there has been no direct measurement of gravitational speed. Looking out into the heavens at how large bodies interact with one another, it is obvious that gravity is much faster than light. For instance, the position in the sky where we see the sun is about eight minutes behind its real

instantaneous position, yet the Earth in its orbit responds to the Sun's real-time position.

Van Flandern suggests an alternate model to gravitational interaction. He proposes a very old idea that perhaps gravity is a "pressure" phenomenon, and not an attractive one. That is, space may be permeated by little entities called c-gravitons, which travel billions of times lightspeed. The continuous interaction of these



Dr. Tom Van Flandern

with masses leads to all the effects we ascribe to gravity. Toss into the picture a light-carrying medium (the "aether") and you have a model that accounts for all the observations now attributed to General Relativity, but does this much more simply. There are a number of experiments that can be done to distinguish between Van Flandern's gravitational theory and the usual ones. One of these is that c-gravitons should be attenuated and eventually blocked by enough matter. Van Flandern showed some tantalizing data collected from satellites that seem to show this very effect in action!

For the free energy enthusiast, the implications of gravity being particulate and perhaps blockable are obvious. Block or deflect the c-gravitons raining down from the sky and up you go into space. Turn off the blocking shield and recover the energy you've gained, for free, as you fall back to Earth.

Van Flandern's views may bother those among us who want to unify all the forces of nature with complex theories untethered to experiment, gravity included, but that's a matter of taste, not physics.

With the speakers' sessions over, a question and answer period ensued that was devoted to providing feedback about how the conference had gone and how it could be made better. Having been run unusually well under trying circumstances, not much needed to be said about this conference.

On Friday evening the conference banquet was held. We were entertained by a local singer and Dr. Paul M. Brown was award-

The Internet is not some magic source of information. It is a huge garbage dump of contradictory information, though here and there scattered gems and nuggets of gold turn up.

ed the "Integrity in Research Award." Our keynote speaker was supposed to be Mary Hutzler from the DOE, but she didn't arrive. On short notice, we were treated to a talk by Mark Goldes of Magnetic Power, Inc. of Sebastopol, California. His presentation was mind-bending, but I'm afraid that we were asked (for the time being) not to disclose the topic in a public forum beyond that dinner. The technical subject was explosive enough (no, it was not about over-unity motors) for our resident skeptic to exclaim rather loudly that Goldes "must be a liar." Still, we didn't kick out this skeptic.

Many of the previous days' speakers also conducted workshops on Saturday. These ran in parallel sessions, so it was impossible to attend them all.

Ken Shoulders held a workshop to provide further details about charge clusters. Unfortunately, several attendees at the workshop had missed the actual talk and, in the process of review, Shoulders pretty much redid his entire talk of the day before. This wasn't superfluous, since many got to see the slides up close this time, and it was still good to interact with Shoulders in a more intimate setting. There were handouts and other data sheets to buy. Most interesting about the session were those questions that got close to Shoulders' "real" work, which he cheerfully declined to discuss.

Following Shoulders came Prof. George Miley of the University of Illinois, who talked about low energy nuclear reactions (LENRs). Miley did not have a previous general session talk, so his information was new to many (unless they subscribed to *Infinite Energy*). Miley described the nature of his work with thin metallic films as cold fusion cathodes, and showed numerous graphs of the data that he collected. This clearly



Dr. George Miley

shows the signatures of very many heavy element nuclear transmutations. The graphs were rich with daughter products with non-natural isotope ratios; there was even put forth evidence for new, transuranic elements within the hypothesized island of stability. One of the great advantages of Miley's work is that it yields so much data with which to try to figure out the nature of the core reactions involved in CF processes. Just finding excess heat and helium is valuable, but three dozen or so anomalous isotope ratios really give the theorist something to think about. These findings powerfully constrain possible theories.

Dr. Graneau spoke in much greater depth about his water arc work, giving a detailed overview of the energy accounting methods used in the lab, more information on the history of

what he has been doing, and hints at the nature of his ongoing work. In some ways it is hard to know where to place Graneau's work in the new energy field. His mundane explanation that his "free energy" is ultimately solar and comes from unaccounted-for binding energy makes it seem that it should have been discovered years ago. If Graneau is right, this tells us a lot: Even a free energy source this easy to understand (and probably acceptable to the mainstream) can go undiscovered for decades despite being right under our noses! On the other hand, if Graneau's explanation is wrong, then we have a surprisingly easy means for tapping into an unknown source of energy. There is no third possibility—the fact that there is excess energy being produced is firmly established. The technology to exploit it is being developed. (Poor Dr. Park; he should have stuck around at least for this talk.)

The final workshop, and perhaps the best attended, was that of Dr. Greer. Greer went out of his way not to repeat himself from the previous day. He opened up the discussion immediately to questions that many still had from the earlier session. Attendees heard a great deal about the who, what, and where of the secret groups responsible for concealing secrets about UFOs and exotic energy technologies. Of course, if one blithely assumes that Greer is making it all up, then there is no need to listen to him at all. But for some of us, he certainly painted a plausible picture of a system within our government that isn't properly controlled

There is only one Physics; that is, one real set of physical principles that describes the Universe.



Subscribers Joe and Laura Maize

by our government.

The approach that Greer outlined is simply good business sense with the recognition of possible suppression forces that may need to be dealt with. But during the questioning some points came up that need to be addressed, the most pertinent of which is the common but bizarre notion that "publishing the information on the Internet" is a kind of cure-all, because then "everyone will have it."

Everyone will have *what*? It is easy to find plans for over-unity devices on the Internet. It is trivial to find patents for such things. Detailed descriptions are a dime a dozen, as are testimonials from scientists who investigated the devices. Perhaps some of these things actually do work. Certainly, some of the inventors were likely to be mistaken in their claims. Maybe some of the plans are even disinformation sown by the suppression folk to keep people distracted.

Who is going to sort through all these claims and find out

which ones work and which ones don't? Some of us do just this kind of thing—it's essentially the mission of NERL and other groups to perform these kinds of studies. But we have bitter experience with just how difficult it is to replicate someone else's work, even when the inventor is willing to help and provide feedback, advice, and even equipment.

The Internet is not some magic source of information. It is a huge garbage dump of contradictory information, though here and there scattered gems and nuggets of gold turn up. You need to have good filters in place to reduce the garbage dump to a single pile of trash, but after that filtering isn't enough. You have to look at the remaining items one by one.

And there is another problem with the Internet, one much harder to see: all the information that is missing that should be there. As I complained to one friend a few months ago, the Internet is a vast E&M wasteland. It is not entirely fair to complain that the Internet lacks data that should be there, but it is important to combat the notion that enough searching through the web will turn up everything. For example, I am right now in the middle of perhaps the most important book on electromagnetism I've ever read. It is entitled *Electromagnetic Theory* and was written by Alfred O'Rahilly. This book came out in 1938, was reprinted by Dover in 1965, but is so obscure that it doesn't even show up in book searches (including out-of-print titles) from Amazon, Barnes & Noble, and Borders. People who rely on the Internet to find it, or to even hear about it, could easily miss this title. (I borrowed the copy I'm reading from Tom Phipps, and I first heard of the book from Peter Graneau.)

There you have it. This was a good convention. For those of you who need a rating of some kind, the First International Conference on Future Energy was a 10, two thumbs up, and four stars. We look forward to next



Ed Wall with NERL's plasma electrolysis device set-up.

Why not give
Infinite Energy
as a Gift
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friend or to your
local library?

We welcome Libby (Elizabeth Grosser) to our growing editorial staff!





DEVICE AND PROCESS TESTING UPDATES

by Jed Rothwell, Ed Wall, and Eugene Mallove

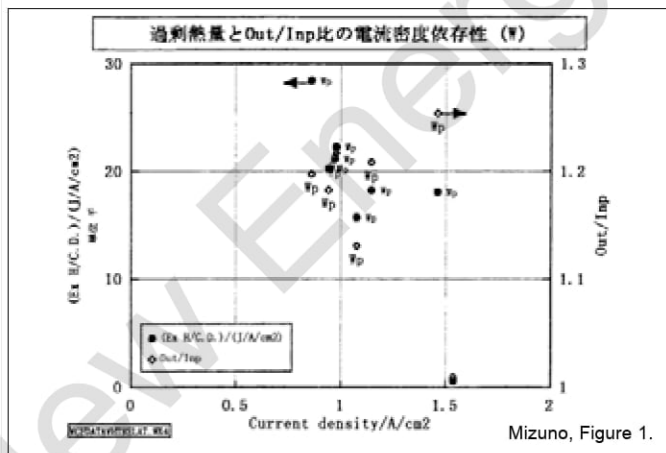
Plasma Electrolysis Experiments

Tadahiko Mizuno (Hokkaido National University) reports continued success with plasma discharge electrolysis cold fusion experiments, which were first reported at ICCF-7 and here. [Ohmori, T., "Strong Excess Energy Evolution, New Element Production and Electromagnetic Wave and/or Neutron Emission in Light Water Electrolysis with a Tungsten Cathode," *Infinite Energy* No. 20]

Mizuno, Ohmori, and Akimoto recently co-authored a paper titled "Production of Heat, Light and Neutrons During Electrolysis in Liquid." They report output energy exceeds input by 30 to 100% or more, as well as evidence for neutrons and transmutations with cathodes made of platinum and tungsten. We will translate this paper and publish it in an upcoming issue.

The calorimetry is improved. Input power, the most problematic parameter, is measured independently with a power meter (Yokogawa WT130), and by collecting the data on computer with a fast data logger (Advantest R7326-B). The computer log and the power meter agree within 0.99 ± 0.07 on average. Cells can now be run with isoperibolic calorimetry as was done previously, or with flow calorimetry. Effluent water vapor is condensed and weighed to the nearest milligram. Runs have been extended to as long as 5000 seconds (83 minutes) by condensing the water and returning it to the cell. Excess heat is observed during the entire period. An analysis of a replication in Canada indicated that the excess heat might be an artifact of the calorimetry, but if this were the case, Mizuno's heat would fade out in for five or ten minutes.

The success rate has risen to roughly seven out of ten experiments. Results from an extensive set of runs lasting 1000 seconds each were graphed to identify control parameters. For example, excess heat with tungsten is only observed when current density is between 0.7 and 1.6 amperes per cm^2 (see Figure 1). Excess heat begins rising exponentially above 75 to 80°.



Mizuno, Figure 1.

In 1998, we were not able to replicate satisfactorily the excess heat in this experiment, and neither was Scott Little of Earth-Tech International, or Jean Paul Biberian at the French Atomic Energy Commission. Clearly, the experiment is more difficult than it first appears, or the excess heat is an artifact of Ohmori and Mizuno's instruments. Mizuno is now collaborating and assisting both us (NERL) and Little, by supplying assembled, prepared tungsten cathodes, and by advising us on how to do the experiment. Unfortunately, the cathodes supplied by

Mizuno are fragile. The lead wire attached to the rectangular foil cathode snaps off easily. All of Little's samples broke before he got a chance to test them. The samples he made by himself did not produce excess heat. Little is using a different type of container and different cell geometry than Mizuno, and the power profile he observes looks different from the one seen in Mizuno's graphs.

In early July, Jed Rothwell will visit Mizuno's laboratory for hands-on training in this experiment. He will make a video of the test procedures and acquire cathode materials, a quartz glass cell, samples of the potassium reagent, and other materials in order to perform a close replication at NERL.

Mizuno reports that a successful replication of the experiment has been performed by Kansai Research, Inc. (KRI), a subsidiary of Osaka Gas (http://www.kansai-ri.co.jp/index_e.html). Scientists at KRI used cathode materials supplied by Mizuno, placed in a 4-liter dewar vessel with 0.2 molar K_2CO_3 electrolyte. The vessel has a thick transparent plastic top, which allows them to look down into the cell to observe and control the glow discharge. They pre-heated the water to 60°C and then ran the plasma electrolysis discharge until the temperature reached 86 °C. In one sample run, total input was 226 kJ, and cell enthalpy was 329 kJ: 3089 grams water * 4.184 * (86.1°C - 60.6°C). Heat release from the Dewar was 11.8 kJ and the enthalpy of the effluent gas was 7.6 kJ, so the total average input to output ratio was 1.54. The output/input ratio has varied from as low as 1.06, to 2.81 maximum.

Catalytic Fusion

The catalytic fusion process of Dr. Les Case got a significant boost in early June. Dr. Michael McKubre of SRI International reported on a series of convincing experiments. These appear to confirm Case's conclusion that helium-4 can be produced by the catalytic action of palladium-doped carbon in heated vessels containing pressurized (several atmospheres) heavy hydrogen (D_2) gas. McKubre spoke on June 3, 1999 at the Society for Scientific Exploration's 18th Annual Meeting, which was held at the University of New Mexico in Albuquerque.

McKubre reiterated the SRI results first divulged at the APS meeting in March by Russ George of Saturna Technologies, Inc. He described the now famous experiment that produced a steady heat output and monotonic increase of helium reaching about 11 ppm from day 5 to 30 of the run (about twice the laboratory and standard atmospheric background of 5.2 ppm).

This and similar experiments at SRI employed sealed 50 cm^3 metal cells connected to a sensitive mass spectrometer, which is well able to separate out the D_2 peak from the ^4He peak. A control cell containing H_2 gas produced absolutely no excess heat or helium. McKubre suggested that excess heat output of about 0.25 to 0.5 watt was possible evidence for the fusion reaction of two deuterium nuclei to helium-4 with an energy release of about 23.8 MeV. The most important news is that SRI has run about a dozen Case cells, with a success rate of about one in two or three. It is not especially easy to do this work—as we at NERL have found in some of our initial experiments. The catalyst has to be kept very clean. (There may also be some special thermal gradient conditions that need to be met.)

Cold fusion skeptic Richard Murray, who attended the SSE meeting, had this reaction initially about the McKubre report: "The fact that the cells can not always be made to work increas-

Device Testing continues on page 41

Unity Solid State Heat Engines

Ken Rauen*

Solid state heat engines have been around for several decades. One type is commonly called a thermoelectric generator (TEG). TEGs generate electricity directly from heat with temperature gradients across solid electrical conductors by thermoelectric effects, often described as the Seebeck, Peltier, and Thomson effects.

The Seebeck effect is depicted in the circuit of Figure 1. Two dissimilar electrical conductors, A and B, are connected to form two thermocouple junctions, J1 and J2. When the two junctions are at different temperatures, T1 and T2, a voltage is created across the two terminals of material B, detected by volt meter VM. The temperature of the B terminals at VM do not matter, but are often at the same temperature as one of the measurement junctions, J2, often called the reference junction. The junctions created at VM, if a different material than B is used in VM, will add no net voltage to the circuit because the temperature of these materials and their junctions are the same, so that the voltages will be the same. The voltages are out of phase and cancel. All contact potentials in this circuit cancel, so the differential circuit voltage measured is purely from the Seebeck effect.

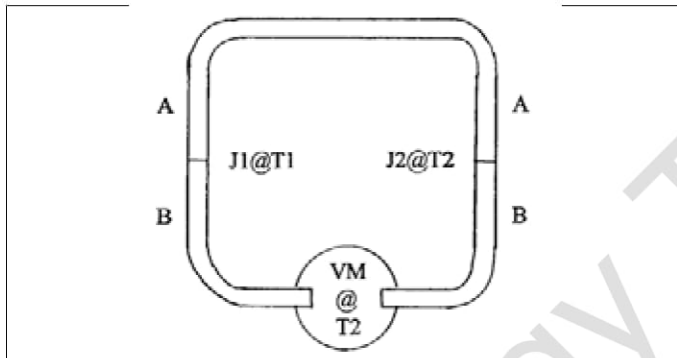


Figure 1

Figure 2 shows a multiplicity of junctions in series, called a thermopile. It generates multiples of the voltage of the circuit of Figure 1. A thermopile demonstrates the Seebeck effect.

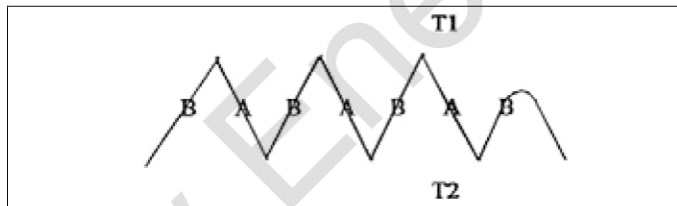


Figure 2

Figures 3 and 4 show the Peltier effect, describing the energy transfers at the thermocouple junctions. Figure 3 has current against the junction voltage and dissipates electrical energy in the form of heat. Figure 4 has current with the junction voltage and cools down, generating electricity from heat.

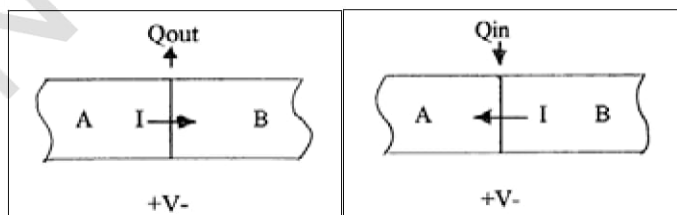


Figure 3

Figure 4

Figure 5 describes the Thomson effect. It is only present in one material with a temperature gradient and creates a voltage along the temperature gradient, with or against the current in the circuit containing this material, and electricity is dissipated or generated.

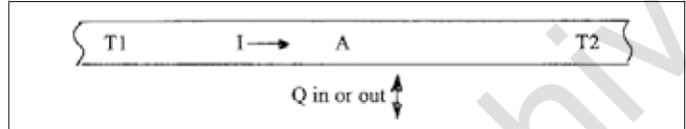


Figure 5

Since the development of thermodynamics in the early years of the industrial revolution, it has been common scientific knowledge that energy must be accounted for and energy transformations occur in such a way that randomness remains the same or is increased. This knowledge is formalized in the First and Second Laws of Thermodynamics. The First Law is the conservation of energy, stating that all energy must be accounted for. The Second Law states that the change of randomness, or change of entropy, in a spontaneous energy transformation must be zero or greater than zero.¹ The conditions by which energy can transform with zero entropy change are called reversible conditions. Irreversible conditions have entropy changes greater than zero. Reversible conditions are not accepted as practical conditions in thermodynamics.

The Second Law is only a statement of collective experience about the flow of energy. The Second Law has never been proven.² Since the Second Law is based upon experience, and the scientific method is founded upon experimental evidence, the Second Law will automatically be extended by new experimental evidence. The prior art of all heat engines, including TEGs, has only demonstrated entropy increasing devices.

A corollary to the Second Law is Carnot's Theorem, which establishes a theoretical maximum efficiency of a heat engine based upon its highest and lowest temperatures. Carnot's Theorem is based upon the Kinetic Theory of Gases (KTG), the fundamental model of the nature of heat. The KTG states that gas particles (atoms or molecules) collide with each other elastically, meaning no energy is lost in these collisions. The KTG also states that the thermal energy of the gas is determined by the kinetic energy of the particles. The particles have a range of kinetic energies characterized as a Maxwell-Boltzmann statistical distribution, and the average kinetic energy is proportional to the gas's absolute temperature. The KTG model also applies to other forms of matter, though it was originally developed to explain gas behavior. Since Carnot's Theorem is derived from the KTG, Carnot only applies to physical phenomena which conform to the KTG. Carnot is not a universal limitation. Carnot has been applied to thermoelectric phenomena. Its application has been appropriate, as all prior art experiences with TEGs have demonstrated efficiencies below Carnot and have had absolute efficiencies generally below 4%.

High efficiency is not uncommon in nature. Supporting evidence for high efficiency energy conversion is found in photovoltaics and fuel cells, though neither are heat engines. Photovoltaics have conversion efficiencies approaching unity when irradiated with monochromatic electromagnetic radiation at the photoelectric potential of the cell. Methane and oxygen fuel cells have a theoretical conversion efficiency of 92%.³ Up to 75% efficiency has been demonstrated,⁴ which is far higher than the effi-

have a theoretical conversion efficiency of 92%.³ Up to 75% efficiency has been demonstrated,⁴ which is far higher than the efficiencies of any classical heat engines operating with this same fuel and oxidizer, releasing the same chemical energy. Carnot does not apply to fuel cells or to photovoltaics; their processes do not conform to the KTG.

There are other examples of high efficiency energy conversion. One is black body radiation, in which thermal energy is completely converted to electromagnetic radiation. No heat must leave a black body radiator in order for light to be radiated. Isothermal compression and expansion in classical thermodynamics are unity conversion processes under reversible conditions with ideal gases; heat is completely converted to work and vice-versa. Practical, irreversible, isothermal engine processes are still highly efficient transformations. Electrostatic loudspeakers convert electrical energy to acoustical energy without dissipating heat, although amplifiers providing the energy to the loudspeakers are not designed to recover the capacitive energy stored in the loudspeakers, and the amplifiers therefore must dissipate the stored energy as heat. Electric motors are examples of near unity conversion of electrical energy into mechanical energy. Falling water is also converted into mechanical energy approaching unity efficiency. All of these examples serve to make us aware that high efficiency energy transformations do occur in nature.

TEGs and their cousins in instrumentation, thermocouples, contain within the established science and technology a widespread demonstration of high efficiency conversion of heat to electricity that exceeds Carnot. It has been observed but has not been recognized until now. Those skilled in the art will recognize its ubiquitous presence from the discussion to follow below.

It is easiest to understand that thermoelectric phenomena are capable of thermal conversion efficiencies much higher than Carnot by examining a thermocouple circuit as it is commonly used as a thermometer. The energy conversion process and basic circuit configuration in a temperature measuring thermocouple instrument are the same as in a TEG, though the instrument is designed as a voltage generator and the TEG is designed as an electrical power generator. A temperature sensing thermocouple instrument is composed of a thermocouple junction as the sensor in the environment to be measured, a second thermocouple junction as the voltage reference at a known temperature, and a voltage sensitive meter to display or record the measured temperature. These three components are connected in a series electrical circuit, with the two thermocouple junctions connected out of phase. By the Seebeck effect, a net circuit voltage is created when the thermocouple temperatures are different. By the Peltier effect and the direction of current, the higher temperature junction cools down and the lower temperature junction heats up. It follows that heat is being converted into electricity in the high temperature junction and electricity is being converted into heat in the low temperature junction.

The measurement thermocouple is in a different thermal environment and often is at a substantial distance from the other two components, connected only by the electrical wires of the circuit. Heat conduction from high temperature to low temperature thermocouple junctions is insignificant and varies with the length and cross section of the conductor, yet performance is unaffected by varying thermal conduction. Temperature stabilization of the leads does not affect performance, so time is not a factor. Whether or not the conductors are insulated does not matter either, so heat flow in or out of the leads to the environment does not matter. Thermocouple voltage is independent of the length or thermal gradient of the thermocouple conductors, and is known as the law of Magnus.⁵ It fol-

lows that no transference of heat from high to low temperature thermocouples is necessary and no rejection of heat is necessary at the high temperature thermocouple generating the electricity. By the many different configurations possible to interconnect the high and low temperature thermocouples, the only configuration which affects performance is what materials compose the thermocouples, which is the beauty and great utility of thermocouples in instrumentation.

It is clearly recognizable that thermal energy conversion at each junction requires no heat transference other than the heat equated with the electrical energy converted according to the First Law. The thermoelectric phenomenon in its fundamental manifestation is inherently a unity conversion process. It is also noted that the unity efficiency thermoelectric phenomenon takes place under conditions that are typically called irreversible: practical, every day conditions. The basic phenomenon of thermoelectric energy conversion is reversible, as classical thermodynamics defines reversibility, even under practical conditions normally defined as irreversible.

Thermoelectric heat pumps also display the ubiquitous presence of unity conversion. Refrigeration occurs at the low temperature junction. This is where heat is converted to electricity, and that thermoelectric junction cools down according to the Peltier effect, just as the high temperature junction does in a TEG. The low temperature junction has nowhere to reject heat; it must convert all heat to electricity to create refrigeration. The only place heat is rejected from a thermoelectric heat pump is at the high temperature junction, and it only comes from electricity. The electricity dissipated at the high temperature junction is a sum of the electrical energy input, which runs the heat pump, and the electrical energy generated at the low temperature junction.

Attributing low efficiency in a TEG to Carnot has a direct parallel to the efficiency of the Stirling cycle heat engine in classical thermodynamics. Work equals the heat in or out of an isothermal process, converting energy at unity efficiency. The only external heat transfers in the Stirling cycle heat engine are through the isothermal processes. The Stirling cycle is Carnot-limited only because isothermal compression, which is the heat rejection portion of the cycle, consumes part of the work generated by isothermal expansion. The work energies generated and consumed in the isothermal processes are proportional to the absolute temperatures of the working fluid, and therefore make the overall cycle Carnot-limited. The thermocouple junctions in classical TEG design are analogous to the isothermal processes of the Stirling cycle. The high and low temperature junctions convert heat and electricity at unity efficiency with contrary energy flows. They offset each other due to common current with different voltage polarity, and therefore opposite Peltier effects. Each junction's Seebeck voltage contribution is proportional to its absolute temperature. Since the current is the same through both junctions and electrical power equals voltage times current, the electrical energies of the junctions are proportional to the absolute temperatures, making the prior art TEG, as a complete device, Carnot-limited.

The reversed junctions in classical thermoelectric circuits buffer the thermoelectric voltages to achieve temperature measurement accuracy in thermometry, and to achieve increased voltage from multiple junctions in series in both thermometry and power generation. Classical thermoelectric devices achieve increased voltage by sequential alternation of forward and reversed junctions composed of two dissimilar conductors. This configuration is called a thermopile. With the thermopile at one temperature, no net voltage is created; the voltage of one forward junction is canceled by the voltage of one

reverse junction. Only when a temperature difference exists between the two junction polarities will a net voltage exist, according to the Seebeck effect. Because of the reversed junction configuration and the Peltier effect, some electrical energy must be wasted as heat proportional to absolute temperature, and the TEG as a whole becomes Carnot-limited. This waste is only due to the circuit configuration and not the underlying energy conversion phenomenon. The prior art identifies no other alternatives to achieve the two objectives of disturbance-free voltage for accuracy and increased voltage.

Additional supporting evidence for unity thermoelectric conversion comes from a standard TEG efficiency equation. The efficiency of a TEG is its electrical energy output divided by the heat input. The heat input of a TEG is composed of Peltier heat at the high temperature junction, plus conduction heat across the electrical conductors connecting the high and low temperature junctions (a loss), minus one half of the Joule heat liberated in the conductors due to resistance (a gain).⁶ A reduction in heat input means this is recycled energy that decreases the need to add as much heat from the outside source, thereby increasing the efficiency. Half of the Joule heat reducing the input heat means half of the electricity that degraded to heat by electrical conductor resistance is thermally conducted back to the high temperature junction to go through the conversion process again. For this Joule heat to enter the high temperature junction, it must have the same temperature as the heat passing through the high temperature junction from the external heat source. This is evidence from conventional science that heat can convert to work and back to heat at the same temperature and, therefore, the same entropy, enabling heat to do work again and again without degradation. Heat is a form of perpetual energy.

The work of Joseph Yater supports the concept of unity thermoelectric conversion. Yater indirectly states in U.S. patents No. 5,356,484, No. 5,470,395, and No. 5,623,119, all entitled "Reversible Thermoelectric Converter," that the quantum well diode devices, the thermoelectric elements in the referenced patents, are essentially unity efficient. Yater uses the term "reversible" not only to describe being capable of heat pump or heat engine operation, but also to describe thermodynamic reversibility. "The theory of the reversible processes of the classical circuit shows that the incoming energy fluctuations in the form of increments of thermal energy are converted into electromagnetic [electrical] energy without, in the limit, any irreversible losses occurring, such as heat losses across the thermal

barrier."⁷ "These results support the conclusion that the thermal energy of the hot electron is directly converted into electromagnetic [electrical] energy before any electron thermalization occurs."⁸ "... processes using either classical or quantum statistics are defined as reversible processes when, in the limiting case, the entropy increase for the process becomes arbitrarily small and when the process is constituted of a succession of ordered equilibrium states."⁹ "The conversion of thermal energy of each hot electron into electromagnetic [electrical] energy occurs in a time interval that is short compared to the relaxation time of dissipative loss sources."¹⁰ "These are essentially statements of unity conversion. Details of the patents give further support for unity and these quotes are only provided as samples from the patent texts. Examples cited in Yater's patents of Carnot efficiency limitations are always in circuits which contain reversed quantum well diodes at a heat rejection temperature."¹¹

Provisions are not made in the aforementioned patents to dissipate heat from the first devices, the high temperature elements in the converters. Heat dissipation is only provided for the low temperature elements.¹² These converters are said to handle high power levels on the order of ten million watts per square meter without self-destruction, further indicating unity or near unity conversion in the individual elements. Thin film thermoelectric converters cannot handle such power by passing heat laterally through the film. Individual elements must be very highly efficient. Yater appears to have demonstrated unity thermoelectric processes, but largely utilizes the classical thermoelectric technique of reversed junctions to build usefully large devices.

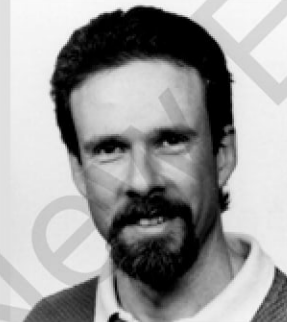
As Yater intimates, reversibility applies in practice to microscopic, atomic level processes ("hot electron conversion time intervals which are short compared to dissipative loss sources"). The atomic level energy transformations are the sole source of thermoelectric energy conversion, and the author postulates that thermoelectric processes are therefore reversible, which is consistent with the elastic collisions of the KTG.

Classical thermodynamic processes also tap microscopic, atomic-sized processes and take them up to the macroscopic level but through a different pathway, which results in lower efficiency. Carnot-limited thermodynamic processes transfer thermal energy into mechanical energy while changing the thermal energy of its working fluid, and can only transfer part of that energy due to the thermal energy distribution difference between the working fluid states. Collisions of high energy particles with low energy particles occur rapidly, and atom-to-atom energy exchanges occur too rapidly for all thermal energy to be passed to the macroscopic level while the average thermal energy is changing. Thermoelectric processes transfer thermal energy into electrical energy without changing the thermal energy distribution in the thermoelectric materials. When thermodynamic processes transfer thermal energy without changing their thermal energy distribution, as in isothermal processes, complete transfer is achieved. Unfortunately, isothermal processes cannot be used alone to convert energy because they are not sustainable processes and must be cycled like all classical, working fluid thermodynamic processes. Thermoelectric processes are sustainable in a long-term, steady state condition, and since the work is being provided from microscopic processes that are inherently reversible, macroscopic operation of thermoelectric devices occurs under reversible conditions and dynamic equilibrium.

Thermoelectric energy conversion has not been recognized as a highly efficient energy transformation process until now. As shown by the examples above, unity efficiency does exist. We

About the Author

Kenneth M. Rauen is a chemist by education and an engineer by experience. He has a B.S. in chemistry from the University of Detroit. Among his professional engagements through the years, he was the Injection Molding Specialist for Technidisc, a laser video disc manufacturer, in the early 1980s just before CDs arrived. Presently, he is a Customer Service Representative for Carl Zeiss



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Rauen continues on page 27

The Second Law of Thermodynamics and the “Death” of Energy, with Notes on the Thermodynamics of the Atmosphere

Charles P. Steinmetz¹

Consulting Engineer, General Electric Company

Submitted by R.A. Ford of Champaign, Illinois²

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General Electric Review, Volume 15, July 1912

Expressing the second law of thermodynamics in the words: “Without expenditure of some other form of energy heat flows only from higher to lower temperature,” the author shows that the logical sequence from this is the conclusion that eventually all energy transformation will stop, i.e., all motion will cease and the universe will be dead. The conclusion is not a reasonable one and the author sets out to disprove the general applicability of the law. Adopting as his line of reasoning the thermodynamics of gases, he shows how, attending the escape of molecules from the attraction of earth into cosmic space, there is a heat energy flow from a temperature of 10°C to one of 60,000°C. Even within the earth’s atmosphere, and without considering what happens in cosmic space, he shows that there is a transference of heat energy from lower to higher temperatures, or rather against the thermodynamic temperature equilibrium; and leads us to the conclusion that this law of thermodynamics is not of universal application, but applies only within the limited range of thermodynamic engines from which it has been derived.—(Editor, General Electric Review)

The second law of thermodynamics may be expressed in the form: “In any cyclic process, the sum total of unavailable heat energy increases.” Thus, if we transform electrical to mechanical energy and backwards, we do not get back the total amount of energy, but some of it is converted into heat. Of this heat energy at least a part can never be re-transformed into any other form of energy, i.e. it has become unavailable. Or the law may be expressed: “Without expenditure of some other form of energy, heat flows only from higher to lower temperature;” that is, from a higher heat level to a lower heat level. In this form the law is easiest to grasp; just as water, without expenditure of outside energy, flows only from higher to lower level.

The result thereof is that the total heat energy can never be used in any case; but that amount which is still heat energy when the lowest heat level or temperature has been reached can not be transformed except by the use of additional energy, i.e., it has become unavailable. Thus of the total heat energy in the superheated steam issuing from the boiler, only that corresponding to the temperature range from admission temperature to the temperature of surrounding space can be used; but



Reprinted from *Charles Proteus Steinmetz*, by L.D. Belkind, 1965 (Russian)

the much larger amount of heat energy which is still contained in the steam exhausting into the condenser at atmospheric temperature is unavailable.

To some extent availability is relative. The heat energy in the steam exhausting into the condenser at atmospheric temperature, which is unavailable under ordinary conditions, would be available in part if we could exhaust at the temperature of liquid air; and of the heat energy remaining in the exhaust at liquid air temperature, a further part could be transformed by exhausting at the temperature of liquid hydrogen, etc. Even between the limits of atmospheric temperature appreciable variations of available energy, and with it differences in the efficiency of steam turbines, etc., are noticeable. However, the total heat energy could be made available only by dropping down to the absolute zero of temperature, and as this can not exist, all the energy, which is still heat energy at the minimum temperature of the universe, has become absolutely unavailable, i.e., it can never be used without the expenditure of some other form of energy.

An analogy is given by water power. Of the energy of a water course, only that represented by the difference in height between the upper level and the lower level is available at the point of development. However, some miles distant, a still

About the Author

¹Charles Proteus Steinmetz (b. 1865, Prussia; d. 1923, Schenectady, New York) immigrated to the United States in 1889. His first major research effort uncovered the law of hysteresis losses, which led to improved efficiency in all electromagnetic devices. His brilliance in mathematical physics led to improved methods for calculating A/C circuit performance and made for rapid progress in introducing commercial alternating current devices. In 1893, he began work for General Electric, a newly formed company in New York. He started out as head of the calculating department and finished employment there as chief engineering consultant. While there he developed a theory of electrical transients, specifically, how to reduce damage to electrical distribution systems from lightning strikes. He authored many textbooks on mathematical electrical engineering and was President of the American Institute of Electrical Engineers (1901-1902). A good source for further reading: *Loki: The Life of Charles Proteus Steinmetz* by Jonathan N. Leonard, published 1929.

²R.A. Ford wrote: “Here is an old favorite article on the Second Law of Thermodynamics. Steinmetz was so well-respected at that time—1912—that no one challenged him on this article; it was just met with silence.” [Thank you for bringing this article to our attention—EFM.]

lower level may exist, and further hydraulic energy made available by it; but finally the ocean level is reached. Here the water still contains an enormous amount of gravitational energy—that corresponding to its distance from the center of the earth. This, however, is now absolutely unavailable, since no lower level exists into which the water can be discharged, and outside energy would have to be expended to make such a lower level.

The result of this functioning of the second law of thermodynamics is that the temperature crests in the universe are leveled off, the temperature valleys filled up, the amount of unavailable heat energy (that below the bottom of the temperature valleys) is increased; in other words the temperature of the universe tends towards a uniformity, at which all the heat energy has become unavailable. The temperature differences in the universe are thus maintained only through the expenditure of other forms of energy, and other energy is thus continuously poured into the gulf of heat energy in producing available heat energy through temperature differences, which again are continuously leveled off and the heat energy made unavailable by the functioning of the second law of thermodynamics; but no return path exists from the unavailable heat energy to other forms of energy.

The outcome of this unidirectional transformation law must be that finally all the other forms of energy will have been converted into heat energy, and all the heat energy have assumed a uniform temperature level, *i.e.*, become unavailable. This means that all the energy of the universe must finally be converted to unavailable heat energy, and if the second law of thermodynamics holds universally, no return exists from this state; hence, the universe must finally run down, just like a clock. All energy transformation will stop, *i.e.*, all motion will cease and the universe will be dead. The energy will still be there—the law of conservation of energy will not have been offended—but as unavailable heat the energy will be dead. It is true that if we define energy as that entity which can do work, it is questionable whether the unavailable heat energy of the dead universe, which can never do any work, can still correctly be called energy.

The second law of thermodynamics is well founded on our experience. The reasoning from this law as to the death of the universe is logical. At the same time, the conclusion that the universe must run down is not reasonable. If the universe is eternal, has existed since infinite time, then it should have run down an infinite time ago. But if it is not eternal, but had a beginning, what was before? How could energy begin without offending the first law, that of the conservation of energy? Thus, in the final reasoning, we arrive at a contradiction.

The explanation may be either that we have attempted to reason beyond the limits of the capacity of the human mind, which, being finite, always fails in the attempt to reason into the infinite, or it may be that the second law of thermodynamics is not of universal application, is not a general law of nature, but is of limited application only. In the following pages I wish to show that the latter is the case. A single exception obviously would be sufficient to show that the second law of thermodynamics is not a universal law, and that the conclusion regarding the death of the world, based on this law, are thus not justified. As the thermodynamics of gases is far simpler and more completely known than any other branch of thermodynamics, it would offer the most promising field of study.

The kinetic theory of gases is probably as fully and conclusively proven as anything can be by the inductive method of science. According to this theory, the heat energy of a gas is the mechanical energy of the irregular molecular motion: the $\frac{1}{2} m v^2$ of the molecules and the atoms in the molecules. The second law of thermodynamics then is nothing but the application—the natural consequence of the operation—of the law of probability. If we bring

together two gases of different kinetic molecular energy, *i.e.*, of different temperature, such as a liter of air at 30 °C and a liter of air at 10 °C, in such a way that the molecules can exchange their motion, *i.e.*, heat can flow between the gases, it is obvious that, in an interchange of velocity between the molecules, one having a velocity above the average is more likely to lose than to gain velocity; a molecule with less than average velocity is more likely to gain than to lose velocity. The result of the interchange of velocity—or rather of kinetic energy, in accordance with the laws existing between bodies, probably the law of gravitation—thus is an averaging of the kinetic energy, *i.e.*, an equalization of the temperature—in the above instance to 20 °C for both liters of air. However, the result of the operation of the law of probability cannot be a perfect equalization of the molecular energies so that all the molecules have exactly the same energy, but sometimes a fast molecule may still gain energy (although it is more probable to lose), or a slow molecule may lose. The result thus would be a distribution of the kinetic energies between all the molecules in accordance with the probability law; and the temperature then represents, or is, the average kinetic energy of the molecules—is represented by an average molecular velocity. This is the velocity found most frequently amongst the molecules; but all higher and lower velocities exist, becoming, however, more and more rare the further they differ from the average velocity, in accordance with the probability law.

Causing heat to flow from a lower to a higher temperature then means separating the faster from the slower molecules. Experience, expressed by the second law of thermodynamics, says that this can be done only by the expenditure of outside energy. However, such a separation of the fast from the slow molecules without expenditure of outside energy would in no way contradict the law of conservation of energy, as Maxwell has shown. Assume that we have a volume of gas at constant temperature—the two liters of air at 20°C resulting from the previous illustration—and have a partition to divide the gas volume in two parts. This partition may be perforated by numerous minute doors, which we assume to have no weight and to move without friction, so that no energy is required to open and close them. Assume now that at every such door we place a demon, who opens the door whenever a fast molecule comes from the right, or a slow molecule from the left, and lets this molecule through; but does not open the door for a slow molecule from the right, or a fast molecule from the left. The result would then be, that gradually the fast molecules would accumulate in the left, and the slow molecules in the right section of the space; that is, without expenditure of outside energy, but through the intelligence of the demons, heat energy would flow from the lower temperature on the right to the higher temperature on the left side of the partition, against the second law of thermodynamics.

Now these demons exist in nature. Every cosmic body is such a demon, and separates the fast from the slow molecules, keeping the latter and sending the former out into space, and thereby causing heat energy to flow into space at a temperature far above its own temperature. Consider for instance our earth. In the uppermost regions of the atmosphere, assume a molecule which happens to be moving in an upward direction, and does not happen to approach another molecule so closely that its direction of motion is changed. Such a molecule will move upwards, until its motion is stopped by the force of gravity, by the attraction of the earth, when it falls back again. If, however, the upward velocity of the molecule is sufficiently high—above a certain critical value—then this molecule escapes from the attraction of the earth into space, and never comes back. This critical velocity at which a molecule escapes from the earth is 11,000 meters per second (see calculation in the Appendix). Assuming the average velocity of the molecules of the air, corre-

sponding to an average terrestrial temperature of 10°C or 283°abs., as 750 meters per second, then the velocity of 11,000 meter seconds corresponds to a temperature of 283 X $(11,000/750)^2 = 60,000$ °C. That is, the molecules which the earth sends out into the universe have a kinetic energy corresponding to a temperature of 60,000°C; or as we may say, by the escape of these molecules heat energy flows from the temperature of the earth, 10 °C, into a temperature of 60,000°C.

This brings up an interesting feature. Since the temperature of the earth steadily decreases with increasing altitude, we usually think of cosmic space as extremely cold—near the absolute zero of temperature. Empty space obviously has no temperature, since temperature is an attribute of the matter in space. Judging the temperature of cosmic space by the kinetic energy of the molecules which have escaped into space from the larger cosmic bodies and which traverse space in irregular motions, we would be led to the conclusion that, far from being extremely low, it would on the contrary be of an inconceivably high value, probably several hundred thousands degrees centigrade. This conclusion would better agree also with the very simple line spectra of gaseous matter in space, as shown by the nebulae.

We may ask, however, whether the kinetic energy of a molecule which, due to its high velocity, has escaped into cosmic space, can still be considered as heat energy. Heat energy is the kinetic energy of irregular molecular motion. The difference between the heat energy of a gas and mechanical energy thus lies in the irregularity of the motion and the size of the moving particles, which is such that only the resultant effect of the mechanical motions of large numbers of moving particles can be perceived. Irregularity of motion, however, is relative; for, if we consider a single molecule which has escaped into space by reason of its high velocity, we can not attribute any irregularity to its motion. That is to say, its kinetic energy cannot further be considered as heat energy; but the kinetic energy of the molecule, which was heat energy while the molecule moved in a mass of gas together with other molecules, is mechanical energy of cosmic motion, and the molecule is a cosmic body, traversing space under the laws of gravitation, but not subject any more to the law of probability of mass action, *i.e.*, to the second law of thermodynamics.

This brings us to the question of the limitation of the conception of heat energy, but for this purpose we do not need to go to cosmic space. If we consider the vacuum tube, and go to the highest vacua—the cathode ray vacuum and beyond—the distances between the molecules become so large that the free path of each molecule becomes appreciable, and the action of the kinetic energy of the individual molecule becomes noticeable. But as soon as this is the case, the kinetic energy of the molecule cannot well be considered as heat energy any more, and

the laws of thermodynamics, which after all are the laws of probability of a mass of moving bodies, begin to fail in their application. Thus Crookes proposed to recognize this condition of a high vacuum, where the molecules act as individuals, as a fourth state of matter. This again throws a side light on the question of the temperature of the cathode ray tube, or the mercury arc in a vacuum. At these very high vacua we may say that we cannot speak of a temperature at all, and heat energy, as the resultant mechanical energy of molecular motion, ceases to exist with the separation of the molecules to such distances that their resultant effect vanishes when compared with their individual actions. When, however, the kinetic molecular energy ceases to be heat energy, the second law of thermodynamics, which is the application of the law of probability, also ceases.

Spontaneously, heat energy flows from a higher to a lower temperature, until equality of temperature is reached, and most methods of temperature measurements are based on this law. However, even this law is correct only within certain limitations. For instance, in the atmosphere of our earth, where there is continuous interchange of heat energy and the air is never at rest, nevertheless no equalization of temperature occurs, and there is no tendency to a condition of equilibrium at constant and uniform temperature—the condition of equilibrium is a definite and very decided decrease of temperature with increase of altitude. If we assume that no heat energy is supplied to or withdrawn from our atmosphere, and that the atmosphere is very thoroughly mixed so as to reach equilibrium condition, then (if for a moment we leave out of consideration the effect of condensation of moisture) the equilibrium condition would be a uniform decrease of temperature with increasing altitude, down to the absolute zero of temperature at an altitude of about 29 km (about 18 miles). As function of the altitude, the theoretical equilibrium condition of temperature, air pressure and air density are shown in Figure 1 assuming 10°C as surface temperature (see derivation of these curves in Appendix). The reason for this is obvious. In the equalization of temperature, whether by the molecules in bulk, in air currents, or by the motion of individual molecules in heat conduction, any upward motion of a molecule

is accompanied by a retardation due to the attraction of the earth, and thereby a decrease of kinetic molecular energy, *i.e.*, of temperature. Any downward motion is accompanied by an acceleration by gravity, and consequently by an increase of kinetic molecular energy and therefore of temperature, and equality of temperature throughout the entire atmosphere is thus impossible with freely moving molecules: the theoretical condition of equilibrium is the temperature distribution with the altitude, in accordance with the adiabatic law.

In accordance with this theoretical law of atmospheric equilibrium, the atmosphere would have a finite limit at about 29,000 meters, at which limit air pressure, density and temperature fall to zero. We

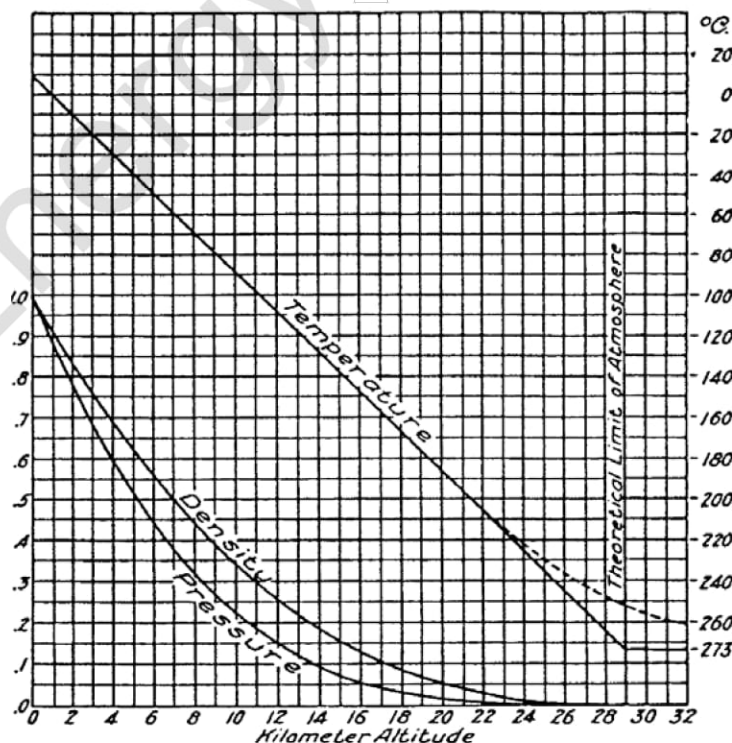


Figure 1. Curves showing theoretical conditions for equilibrium of temperature, air pressure, and air density, assuming a surface temperature of 10°C.



Reprinted from *General Lectures on Electrical Engineering* by Charles Proteus Steinmetz, McGraw-Hill Book Company, Inc., New York, 1918.

know, however, that an appreciable atmosphere extends very far beyond these limits, and for the upper regions of the atmosphere, this theoretical law of equilibrium thus fails. However, this equilibrium condition is based on thermodynamic relations, i.e., is that corresponding to the average velocity of the air molecules. The

molecules, which have a higher velocity than the average corresponding to the temperature, are capable of reaching up to correspondingly higher altitudes—beyond those that would limit the extent of the atmosphere if all its molecules had the same average velocity.

Thus even in our own atmosphere, and without going beyond it into cosmic space, the law of gravitation is doing the work of Maxwell's demons in separating the faster and the slower molecules, and collecting the former in the higher regions of the atmosphere. Thus the second law of thermodynamics does not apply to the atmosphere of the earth, since kinetic molecular energy is transferred from the regions of lower molecular energy to regions of higher energy; that is, heat energy flows from lower to higher temperature, or rather flows against the thermodynamic temperature equilibrium. Furthermore, this phenomenon is not beyond the limits of heat energy—that is, in the range where the molecules act as separate masses—and their kinetic energy thus is not heat energy but mechanical energy. In the present case, however, the phenomenon applies to the resultant kinetic molecular energy, that is, to the temperature. The average kinetic energy, and thus the temperature of the upper regions of the atmosphere, must be higher than that which corresponds to the theoretical thermodynamic equilibrium.

Thus we are led to the conclusion that the second law of thermodynamics is not a universal law of nature, but applies only within the limited range of thermodynamic engines from which it has been derived. It does not apply to the universe as a whole; and the conclusions derived from it, that the universe must finally come to a standstill, are not justified.

APPENDIX

A. Critical Velocity of the Escape of Molecules from the Attraction of the Earth, into Cosmic Space.

Let:

$g = 9.81$ meter sec.² = acceleration of gravity at surface of earth.

$r = 6.37 \times 10^6$ meters = radius of earth.

At an elevation x above the surface of the earth, the gravitational acceleration, which is inversely proportional to the square of the distance from the center of the earth, then is:

$$\frac{d^2x}{dt^2} = -\frac{gr^2}{(r+x)^2} \quad (1)$$

this gives:

$$\frac{d}{dt} \left(\frac{dx}{dt} \right)^2 = -\frac{2gr^2}{(r+x)^2} \frac{dx}{dt}$$

and is integrated by:

$$v^2 = \left(\frac{dx}{dt} \right)^2 = \frac{2gr^2}{r+x} + c \quad (2)$$

where c is the integration constant, and v the velocity of the molecule at the elevation x .

Let:

v_0 = initial upward velocity of the molecule at the surface of the earth, or for $x = 0$. Substituting this into (2) gives the integration constant:

$$v_0^2 = 2gr + c$$

$$c = v_0^2 - 2gr$$

and, substituting in (2):

$$v^2 = v_0^2 - 2gr \left(1 - \frac{r}{r+x} \right) \quad (3)$$

The critical velocity of escape into the universe is then given by the condition that v becomes zero for $x = \infty$. This, substituting in (3), gives:

$$v_0^2 = 2gr$$

$$v_0 = \sqrt{2gr}$$

or, substituting the numerical values, approximately:

$$v_0 = 11,000 \text{ m sec.}$$

B. Thermodynamic Equilibrium of the Atmosphere

The general thermodynamic gas equation is, with sufficient approximation for the present purpose:

$$pV = \frac{r_0 T}{M} = RT \quad (5)$$

where:

p = pressure,

V = volume per unit weight,

T = absolute temperature.

M = molecular weight, approximately 29 for air, and

$r_0 = a$ constant, = 848

and:

$$R = \frac{r_0}{M} = 29.$$

The adiabatic relations between pressure and volume are:

$$pV^\gamma = p_0 V_0^\gamma \quad (6)$$

where:

$\gamma = 1.4$ for air, with sufficient approximation.

If then:

w = weight per unit volume, the pressure distribution in the atmosphere is given by:

$$dp = -w dx \quad (7)$$

where:

x = height above the surface of the earth.

It is:

$$w = \frac{1}{V} = \text{weight per unit volume} \quad (8)$$

and since by (6):

$$\frac{V_0}{V} = \left(\frac{p}{p_0} \right)^{\frac{1}{\gamma}} \quad (9)$$

it is:

$$w = \frac{1}{V_0} \left(\frac{p}{p_0} \right)^{\frac{1}{\gamma}} \quad (10)$$

substituting (10) in (7):

$$dp = -\frac{1}{V_0} \left(\frac{p}{p_0} \right)^{\frac{1}{\gamma}} dx \quad (11)$$

or:

$$p^{-\frac{1}{\gamma}} dp = -\frac{1}{V_0 p_0^{\frac{1}{\gamma}}} dx$$

this is integrated by:

$$\frac{p_0^{\frac{1}{\gamma}} - p^{\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}} = \frac{1}{V_0 p_0^{\frac{1}{\gamma}}} x$$

or:

$$\left(\frac{p}{p_0} \right)^{\frac{1-\frac{1}{\gamma}}{\gamma}} = 1 - \frac{1}{p_0 V_0} x \quad (12)$$

or by (5):

$$\left(\frac{p}{p_0} \right)^{\frac{1-\frac{1}{\gamma}}{\gamma}} = 1 - \frac{1}{RT_0} x \quad (13)$$

where the values T_0 , p_0 , V_0 are those corresponding to the surface of the earth.

From (13) follows:

$$\frac{p}{p_0} = \left[1 - \frac{1}{RT_0} x \right]^{\frac{\gamma}{1-\frac{1}{\gamma}}} \quad (14)$$

where:

$$c = 1 - \frac{1}{a} = 0.285$$

From (6) and (5) follows:

$$\frac{v_0}{v} = \frac{\delta}{\delta_0} = \left(\frac{p}{p_0} \right)^{\frac{1}{\gamma}} \quad (15)$$

where δ = air density

and:

$$\frac{T}{T_0} = \left(\frac{p}{p_0} \right)^c \quad (16)$$

hence:

$$\left. \begin{aligned} \frac{p}{p_0} &= \left[1 - \frac{1}{RT_0} x \right]^{\frac{1}{c}} = \left[1 - \frac{x}{29,000} \right]^{1.4} \\ \frac{\delta}{\delta_0} &= \left[1 - \frac{1}{RT_0} x \right]^{\frac{1}{\gamma c}} = \left[1 - \frac{x}{29,000} \right]^{2.5} \\ \frac{T}{T_0} &= \left[1 - \frac{1}{RT_0} x \right] = \left[1 - \frac{x}{29,000} \right] \end{aligned} \right\} \quad (17)$$

where the average surface temperature of the earth is assumed as 10 deg. C., or $T_0 = 283$.

The values (17) are plotted in Fig. 1.



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Letter to *Physics World*
by Dr. Les Case and a Response

In mid-March Dr. Les Case wrote a letter to Physics World concerning specific errors that appeared in David Voss's article, "Whatever Happened to Cold Fusion?" (Physics World, March 1999, pp.19-20), in which his catalytic fusion process was discussed. With Case's permission, below we reprint his letter to Physics World and supporting documents concerning helium measurements.

We also reprint Editor Dr. Peter Rogers' response to Dr. Case, in which he claims not to have enough space to publish this important letter. This is disgraceful. So, Physics World now joins the ranks of Nature and Science magazines in refusing to publish certain key rebuttal letters that find technical fault with peer-reviewed articles purporting to find no evidence for low-energy nuclear reactions, or journalistic accounts that are generally disparaging to the field. (In Infinite Energy No. 25, p. 22, a review of Voss's article appears.)

Apart from a recent anomalous success in getting several letters critical of another David Voss anti-cold fusion piece ("‘New Physics’ Finds a Haven at the Patent Office," Science, May 21, 1999, p. 1252) published in Science (in the June 18, 1999 issue, pp. 1929-1930), it has been very difficult for the cold fusion and new energy field to correct false impressions planted by shoddy science journalism and the "sneer review" process.—EFM

The Editor
Physics Week
Dirac House, Temple Block
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March 17, 1999

In your recent article, "Whatever Happened to Cold Fusion," (March 1999) the author did not exactly distinguish himself as either a science writer, or reporter.

Specifically, he quoted Lynn Marshall of Lockheed Martin at length, apparently without reviewing the actual data, and certainly without asking for my comments. I enclose copies of five pages faxed to me by Marshall.

1) He never examined my "cells," but only gas samples thereof.

2) Very importantly, the “background” he appears to rely upon is the He content of his in-house D₂ gas, which consistently runs at roughly 50 ppm, grossly high. He quite overlooks my UHP D₂ (and the actual starting material) in which he finds undetectable He. Using his contaminated D₇ as his “background” for my product samples is unscientific, at best.

3) The reporter quotes Marshall as referring to “substantial amount of air in the sample (sic),” clearly referring to Samples No. 10391 and 10464, No. 3, and neglecting the other two samples analyzed. Marshall makes no mention of the He content of air out.

And, numerically correcting for the He introduced along with the introduced air (a standard exercise in sophomore-level stoichiometry) appears beyond his ken.

4) In telephone conversations, Marshall exhibited an inability to convert from ppm to percent. (See the crossed-out “.001” and inserted “.01” on the June 14 fax. It is not clear to date which is correct, and whether he was measuring 5-10 ppm He, or 50-100 ppm, as exhibited.

5) In the June 14 fax, Marshall reports determining 0.0007% Xe, and 0.001% Kr, both startlingly unexpected and unexplainable. These determinations cast further doubt on Marshall’s experimental technique.

6) Even if the reporter had been unable to digest the above, Marshall's use of "fax (sic)" as a past tense verb should clearly have alerted him to possible problems.

7) I clearly informed your reporter that I was working in "catalytic," not "cold," fusion. He fails to note the difference, and import, thereof.

8) I correctly and accurately told your reporter that I had been verbally informed by Marshall of finding “about 91 ppm” of He. (See the June 14 fax.) This quote is missing from the article, and substituted by the lengthy quotations from Marshall, discussed above.

▶ In sum, your article appears approximately suitable for publication in *Time Magazine*. Was that your intent?

Finally, with the clearly positive and definitive results due shortly, and certainly this year, your magazine can congratulate yourself on publication of one of the last gasps of the know-nothing naysayers.

Very truly yours,

Physics World Response

Mr. Les Case
Fusion Power, Inc.
P.O. Box 495
Greenland, NH 03840 USA

Dear Mr. Case,

Thank you for submitting your letter to the Editor about cold fusion. I regret that due to a large number of letters submitted recently and pressure on space, we shall be unable to publish it.

Thank you for your interest.

Yours sincerely,
Dr. Peter Rodgers, Editor

REQUEST FOR GAS ANALYSIS											
Special Mass Spectrometer Laboratory											
SUBMITTED BY <i>R. Roy</i>		DATE <i>14 June 96</i>		SAMPLE NUMBER <i>10446</i>							
REPORT TO <i>Joe Case / R. Roy</i>		ANALYST NUMBER <i>74-1-3113</i>		SERIAL NUMBER							
				CHECKED NUMBER <i>500 9320</i>							
(Results Reported in Volume Percent Unless Otherwise Specified)											
SAMPLE NUMBER	H ₂	N ₂	CO ₂	A ₂	O ₂	H ₂ O	HC	He	HC*	C ₂ H ₆ *	Mass %
<i>MADISON</i>	/	/		.009	.004	.049	.88	/	.15	.9877	.00
<i>LHP</i>	/	/	.007	.002	.001	.067	.89	/	.19	.9885	/
<i>SAMPLE #1</i>	.007	.001	.008	.009	.16	.26	.95	.01	.63	.965	.31
<i>ANSWERS WERE FAX TO LES CASE</i>											
*HC = Hydrocarbons Calculated as Mass % = .35 + .21 (Mass % Ethane Specified)											
<i>All answers are the average of 4 runs.</i> <i>Please Note: Mass 18 in Sample #1 and the</i> <i>High HD in Sample #1, also the Ratio of C₂ is #1</i>											
APPROVED BY <i>J.B. Gibson</i>		DATE		ANALYST <i>Jim Mahell</i>		DATE <i>18 June 96</i>					

REQUEST FOR GAS ANALYSIS
Special Mass Spectrometer Laboratory

ANALYST: **6/19/10/464** **B₂** DATE: **4-26-76** CHARGE NUMBER: **50029200**
 SAMPLE NO. AT: **RAISER RAY (from the driver)** ANALYST: **7-26** DATE: **7-26-76** FOR: **Is (603) 772-9200**

REPORT TO: **LC CASE (FPI) - ROBERT RAY**

(Results Reported in Values Percent Unless Otherwise Specified)

SAMPLE NUMBER	As	Ki	CO ₂	Ar	O ₂	N ₂	H ₂	HC	Calculated?	Notes
#10391	1	/	102	.76	12.58	64.98	2.12	0.13	2.03	20.2
4-5-76	2	/	10	.79	18.7	65.12	2.39	0.13	5.34	2.52
	3	/	10.9	.76	17.62	64.9	2.13	0.12	3.02	2.0
	4	/	10.99	.79	19.14	65.75	2.33	0.13	5.12	2.54
Exp. D. Res.	1	/	10.6	.76	12.58	64.98	2.12	0.13	2.03	20.2
4-5-76	2	/	10.6	.79	18.7	65.12	2.39	0.13	5.34	2.52
	3	/	10.6	.76	17.62	64.9	2.13	0.12	3.02	2.0
	4	/	10.69	.79	19.14	65.75	2.33	0.13	5.12	2.54
#10445	1	/	10.74	.76	12.58	64.98	2.12	0.13	2.03	20.2
6-11-76	2	/	10.71	.76	12.58	64.98	2.12	0.13	2.03	20.2
	3	/	10.62	.76	12.58	64.98	2.12	0.13	2.03	20.2
	4	/	10.71	.76	12.58	64.98	2.12	0.13	2.03	20.2

*HC - hydrocarbons Calculated as H₂ + C₂ + C₃ + C₄ + C₅ + C₆ + C₇ Unless Otherwise Specified

Physics World continues on page 69

American Physical Society Features Cold Fusion Session at Its Centennial Meeting "Palladium Electrochemistry"

by
Jed Rothwell and Eugene Mallove

The American Physical Society celebrated its 100th Anniversary in conjunction with the 1999 Centennial Meeting, held March 20-26 in Atlanta, Georgia. The Centennial program included special Centennial events and combined the traditional March and April meetings of the Society, with all APS units participating in the scientific program. There were reportedly about ten thousand attendees from around the world, including approximately forty Nobel laureates.

As the meeting wound down on the afternoon of Friday, March 26, the exhibit hall was taken down and lay barren, but scientific sessions continued in smaller rooms throughout the giant Georgia World Convention Center. A gathering of cold fusion scientists met at 2 p.m. in a session dubbed "Palladium Electrochemistry." This had been selected so as not to "offend" too many of the approximately one thousand indignant physicists who had cheered the public mockery of cold fusion at the "Pseudoscience" spectacle on Monday afternoon, March 22 (see *Infinite Energy* No. 25, pp. 23-25).—Eugene Mallove

Infinite Energy Editor Jed Rothwell, who lives in the Atlanta area, filed this report:

Here is a brief look at the APS session on cold fusion, ZC07.DCMP: Palladium Electrochemistry, which was held on Friday March 26, at 2 p.m. It was organized and chaired by Scott Chubb of the Naval Research Laboratory and Oakton International, who did a great job and deserves a round of applause. This was one of the best cold fusion meetings I have attended. It was short, but informative.

By 2 p.m. Friday, the APS meeting was pretty much over. The exhibitors left on Thursday, and most attendees left Friday morning. The registration and information booths were closed, so people who showed up especially for the cold fusion session had difficulty learning where it would be held. On the other hand, they did not have to pay admission. I did not count the participants but I estimate that fifty people showed up, which was more than I expected. There were approximately ten diehard supporters of cold fusion in the front row. In the back rows were thirty or forty curious people who dropped in. Most of them were young people who had never heard of cold fusion. The opposition was represented by Douglas Morrison of CERN and a smirking reporter from *U.S. News and World Report* magazine, who sat next to Morrison. (*Editor's note:* U.S. News did no story on this session.)

The six formal presentations were limited to ten minutes each. They were followed by a spirited, open-ended informal discussion.

Scott Chubb introduced the session. He noted that this is the first time the APS has had a session devoted to cold fusion since 1989 (the infamous Baltimore meeting, May 1, 1989, at which cold fusion was ridiculed and supposedly debunked by some Caltech and MIT chemists and physicists). He said that the name "cold fusion" is unfortunate because it led many physicists to "believe that there had to be high energy particles involved," but cold fusion produces only heat and transmutations. He avoided that word "transmutations," calling them "residual nuclear by-products." He cited helium-4 and helium-3, which occur at levels that "confound imagination," as he put

it. I do not think the name cold fusion led these physicists to expect high energy particles. Their theories made them expect particles, which made them doubt cold fusion at first, and later despise it. This was inevitable. As Juliet loved Romeo despite his name, so some physicists will hate cold fusion no matter what you call it. To paraphrase—or mutilate—her lines, the physicists might say:

Tis not thy name that is my enemy.
Thou art thyself, and not a Tokamak.
What's a Tokamak? It is nor hand, nor foot,
Nor arm, nor face—It's funding,
Belonging to us. O, be some other name!
What's in a name? That which we call a rose
By any other name would smell as sweet.
So cold fusion would, were it not cold fusion call'd,
Retain that dread heresy which it owes
Without that title . . .

(*Romeo and Juliet*, Act 2, Scene II, with apologies)

The Presentations

14:00 ZC07.01 "A Search for Cold Fusion Heat from Deuterided Pd Powder," T.A. Chubb, S.R. Chubb (Oakton International Corporation, 5023 N 38 Street, Arlington, Virginia 22207), G.L. Schmidt (New Mexico Engineering Research Laboratory, 901 University Boulevard SE, Albuquerque, New Mexico 87106-4339)

Palladium black was exposed to high-pressure deuterium gas. No excess heat was observed. This experiment was inspired by the Arata-Zhang work (see *Infinite Energy*, No. 18), but it is quite different in many ways. Chubb *et al.* use mechanical pressure loading—with pumps—in a stainless steel cell, whereas Arata uses electrochemical loading and the spillover effect to force deuterium into the palladium black inside a specially designed palladium metal container. The cell was operated at high temperature and pressure. They did a good job measuring loading and avoiding contamination from vacuum pumps and other sources. I do not think the temperature or pressure were cycled, as they have been in most previous gas loading experiments.

14:12 ZC07.02 "Cavitation Produced Anomalous Heat," R.S. Stringham (First Gate Energies, 2166 Old Middlefield Way, Mountain View, California 94043)

Roger Stringham was unable to attend, so Scott Chubb read this paper in his place. This was similar to Stringham's previous presentation (see ICCF-7, p. 361). In this device, acoustic waves cause cavitation, driving deuterium into targets of silver, copper, titanium, nickel, and palladium targets. A piezo device, such as the kind used in an ultrasonic jewelry cleaner but much more powerful, is used to generate sound waves, usually at 40 kHz. Excess heat and transmutation reactions occur with deuterium, but not with hydrogen control cells. The foil targets are 5 cm square and 100 microns thick. A joule heater for calibration is employed. The cell holds 50 milliliters of fluid, which is cycled through the cell at a rate of 30 milliliters per minute. The device produces tritium and copious helium with unnatural He-4/He-3 ratios. Most of the He-3 is probably the decay product of tritium.

Stringham uses static calorimetry. His ICCF-7 paper, Figure 1, shows calibration data with a Delta-T up to 60°C.¹ (I discussed this paper with Stringham. He does use static calorimetry, as I thought. The fluid is circulated through the cell and through a bubbler and filter, not in order to cool it so much as to clean it.) The text says: "there were four reactor volume output TC's (K-type thermocouples), two ambient temperature TC's, two reactor containment TC's, output from two 3400A HP voltmeters . . . And

output from a Semitronics watt meter measuring the watts to the joule heater . . . The joule heater data is collected as the average of the four TC's with a maximum deviation between them of 1°C . . ." In a typical recent run, the power supplies consumed 30 watts AC and produced 15 watts of waste heat. The reactor consumed 15 watts and output 40 watts. The cell is run for twenty-four hours with sonication power, followed by twenty-four hours with a joule heater set at the same power level. After three hours, a steady state temperature is achieved, measured by all thermocouples and the pyrometer, which agree closely. In the ICCF-7 paper, excess heat was observed consistently in forty-three runs, and no excess was seen in forty-three calibration runs.

SEM photos of targets that produced excess heat show tiny spheres of metal ejected from holes in the metal surface. This is vaporized and resolidified material, similar to that observed by Ohmori and Mizuno. Stringham says such tiny holes cannot be caused by chemical energy, because chemical energy density would not be concentrated enough to vaporize material in such small spots. Molecular reactions propagate at the speed of sound, by definition: sound is based on molecular pressure waves. In other words, molecular and atomic (chemical) heat work by vibrating molecules, so it would spread out from a tiny point source before the metal vaporized. A chemical or electrical heat source could vaporize a much larger area, or it could vaporize the entire sample, but not such a small area. A laser might be able to vaporize such a small spot, and a nuclear reaction certainly could.

14:24 ZC07.03 "Solid State Nuclear Reactions: Several Convincing Experiments," Eugene F. Mallove (New Energy Research Laboratory-NERL, P.O. Box 2816, Concord, New Hampshire 03302-2816)

Mallove reviewed some basics of cold fusion, pointing out, for example, that the energy releases are far beyond the limits of chemical energy storage. He listed some of the putative causes of the reaction, starting with "fuddy-duddy, mainstream" deuterium reactions that produce helium, and going on to the Mills theory and speculation that ZPE is somehow involved. He also reviewed his direct observation last spring of Les Case's catalytic fusion cell experiment at NERL in Bow, New Hampshire—an all-day experiment during which a temperature differential of 13.2 °C was found between the catalyst with ordinary hydrogen gas and the same catalyst with deuterium gas (see *Infinite Energy*, No. 19). He mentioned the continuing mystery of calcium occurrence in an initially calcium-pure plasma-discharge electrolysis exploration cell, (see Testing Updates, *Infinite Energy*, No. 24, pg. 3).

Mallove distributed copies of the Cold Fusion 10th Anniversary issue of *Infinite Energy*, No. 24, and referred the audience to the list of outstanding papers beginning on page 29 in that issue.

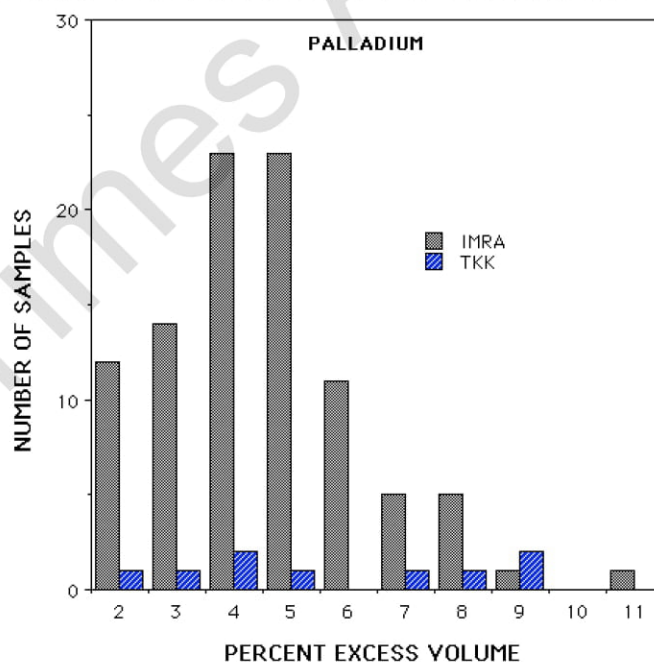
14:36 ZC07.04 "Rules for Coherent, Low Temperature Nuclear Reactions in Solids," Scott Chubb, Talbot Chubb (Oakton International Corporation, 5023 N. 38 Street, Arlington, Virginia 22207)

14:48 ZC07.05 "Anomalous Heat Generated by Electrolysis Using a Palladium Cathode and Heavy Water,"* E. K. Storms (Energy K. Systems, Santa Fe, New Mexico 87501)

Storms was unable to attend, so Michael McKubre of SRI International read this in his place. Storms described the reproducibility problem, which is often misunderstood. Cold fusion almost always occurs when the correct conditions are achieved and is relatively easy to see when the conditions have been obtained, but it is very difficult to achieve them. Essentially, you

**Infinite Energy* will be publishing this paper in a future issue.

have to reach high-loading, intense hydrogen surface activity (chemical potential) as measured by the open circuit voltage (OCV), while you have to keep the metal intact. This is somewhat like reaching the top of Mt. Everest intact; it is hard to get there but you always know when you have arrived. McKubre described his own experience: "When we perform our experiments as well as we can, and we perform them with as nearly ideal materials as we can procure, in as careful a way as we can, the experiments quite literally do not appear to reproduce. And these are perfectly mundane observations. This has nothing to do with cold fusion or excess heat. Mundane things in the deuterium-palladium system are apparently not reproducing, which means there are components of our experiment which are outside of our experimental control. Now what Ed Storms has done, in a very careful and patient study, is focus attention on . . . crucial parameters of the deuterium palladium system which are out of our control, and which contribute to this apparent irreproducibility." In this talk, difficulties with excess free volume were emphasized. A lattice must expand when deuterium atoms are forced into it, even when bonds between palladium atoms remain intact. The amount the lattice will



expand can be determined from first principles and x-ray diffraction patterns. However, in some cases, the metal expands beyond this minimum amount because palladium bonds break. The deuterium wedges the lattice apart, fissures and voids appear, the lattice is destroyed, and the deuterium escapes.

One of the most interesting graphs, reproduced here, showed expansion for ninety samples of palladium. In his paper "How to Produce the Pons-Fleischmann Effect,"² Storms shows that palladium, which expands more than 2 or 3% in volume, will never produce excess heat. He showed that all of the metal samples produced by NEDO exceeded this limit by a wide margin. Some expanded more than 20%. This was a revelation to Douglas Morrison. He seemed amazed to hear that expansion is a problem. This is surprising because expansion has been discussed at each of the last five ICCF conferences which Morrison attended.

In a heated discussion after all the lectures had been presented, Mallove pointedly and angrily asked Morrison, "Douglas, please tell me, do you actually believe what you are saying?" Mallove was referring to Morrison's endless recitation of the "requirement" to observe standard d-d reaction products, which

sounds like a broken record that has refused to stop since 1989.

15:00 ZC07.06 "Evidence for Concomitant Heat and Helium Production in the D/Pd System," Michael C.H. McKubre, Francis L. Tanzella (SRI International, Menlo Park, California)

This presentation was outstanding. McKubre described three experiments that demonstrate helium *commensurate* with excess heat. Commensurate, in this case, means that the SRI researchers recovered 99% of the helium you would expect from a conventional, hot fusion D-D, 23.8 MeV reaction producing the same amount of heat. These results agree closely with results from Dr. Melvin Miles of the U.S. Navy and the Italian INEA laboratories. McKubre began by saying: "The evidence for excess heat is much stronger, in my view, than the evidence for concomitant nuclear processes. Part of the reason is because it is very difficult to do both experiments simultaneously." He described three projects at SRI:

1. Experiments performed mainly by Dr. Ben Bush with a Seebeck calorimeter, inspired by Melvin Miles. Effluent gas from an open cell sweeps through the collection flask. After multiple volumes of gas pass through the flask, it is sealed off and sent to another laboratory where helium is measured. This confirmed Miles' result (see Navy report in *Infinite Energy*, No. 15/16), except in two cases, where heat was observed but no significant helium was found. (Miles saw a deficit in some cases, but he always observed significant helium when excess heat was present.) They assumed this was because the helium was trapped in the metal, a hypothesis confirmed by the next experiment. They never observed helium without excess heat. McKubre concluded that "the results support closely those of Mel Miles in an apparatus that is more rigorously sealed than Miles'."

2. Experiments performed in 1994 by Smedley and Crouch-Baker, with a leak-tight, closed calorimeter. Samples of gas from the head space were drawn once a day. At first the helium appeared to be only 63% of the expected value, however, another sample taken a few days later showed concentration had increased to 66%. It stayed at that level for a while. The cathodes were de-loaded and loaded, the temperature was cycled, the amount of helium climbed and then leveled off, and after three weeks 99% of the expected amount of helium was found in the head space. This indicates that at first helium is trapped in the metal lattice close to the surface. It gradually leaves the metal and is dissolved into the electrolyte, and from there it gradually escapes to the head space where it is sampled. Miles also believes that the helium deficits he sometimes observed were caused by this mechanism.

Unfortunately, the data from this SRI experiment appears in the second volume describing EPRI's cold fusion research, and this publication costs \$20,000. (The book is free to members of EPRI, which is a consortium of electric power companies.) It is a terrible shame that these spectacular results are effectively kept secret behind this \$20,000 barrier.

Morrison asked why the second experiment has not been repeated. McKubre explained that the data shown represents five man-years of work and a huge amount of money, so he is looking for cheaper, "cleverer" ways to do it. He thinks the Case experiments fit this description, and he said they are "almost ready for prime time," which means that he is nearly ready to present these results at a conference. He intends to check six samples from the Case cells for helium-3.

3. Replications of the Les Case experiment (see *Infinite Energy*, Nos. 19 and 23), which have mainly been performed by Russ George and Tanzella, under the guidance of Les Case. This was one of the most important cold fusion papers ever presented. Since Russ George was in attendance, McKubre stepped aside and George briefly described replications of the Case cell. In this

experiment, palladium on carbon catalysts are exposed to deuterium gas. Excess heat and helium are detected. George first showed a graph demonstrating the resolution of their on-line mass spectrometer, which clearly separates peaks for deuterium and helium-4 (4.02820 a.m.u. versus 4.00260 a.m.u.). Then he showed two helium production curves in one graph. Two cells were run side by side, one with hydrogen, the other with deuterium gas. The hydrogen sample did not produce excess heat or significant helium. The deuterium sample produced steady excess heat and a steady increase in helium concentration up to 11 ppm for 28 days, when the experiment was terminated. This is far above atmospheric concentration of 5.2 ppm. Contamination is ruled out, because a leak could only reduce the level of helium. This experiment is now being reproduced at SRI and two other laboratories. George said it is slow and difficult work.

In addition, Professors George Miley, Heinrich Hora, and others presented cold fusion-related papers in oral sessions and poster sessions:

Session FB04, "Heavy Ions I: Exotic Masses and Near-Coulomb Energy Processes," ORAL session, Monday afternoon, March 22, Room 204E, GWCC.

[FB04.04] "Proton Reactions in Metals with Boltzmann Distribution similar to Nuclear Astrophysics," Heinrich Hora (Department of Theoretical Physics, University of New South Wales), George Miley (Low Energy Nuclear Reactions Lab, University of Illinois, Urbana, Illinois 61801), Jak Kelly (Department of Applied Physics, University of Sydney), Frederick Osman and Reynaldo Castillo (Department of Physics, University of Western Sydney, Macarthur)

[FB04.05] "Proton-Metal Reactions in Thin Films," George Miley, Giovanna Salvaggi, and Antonio Tate (Low Energy Nuclear Reactions Lab, University of Illinois, Urbana, Illinois 61801), Heinrich Hora (Department of Theoretical Physics, University of New South Wales)

Session RP01 - Poster Session VI. POSTER session, Wednesday afternoon, March 24, Exhibit Hall, GWCC

[RP01.193] "Coherent Lattice Accelerator Inter-ionic Reactions Enhancer," Giovanna Salvaggi and George Miley (Low Energy Nuclear Reactions Lab, University of Illinois, Urbana, Illinois 61801), Vittorio Violante (ENEA, Divisione Fusione, Centro Ricerche Frascati, 00044 Frascati, Italy).

References

1. Stringham, R. *et al.*, 1997. "Predictable and Reproducible Heat," Proceedings ICCF-7, p. 361.
2. Storms, E.K., 1995. "How to Produce the Pons-Fleischmann Effect", *J. Fusion Technology*, 29, p. 261.

Rauen continued from page 19

now have a basis to look for high efficiency devices. Thermoelectric phenomena can bring unity efficiency to real world heat engines. It is time to look beyond conventional thermoelectric designs and find a way around the reversed junction technology.

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1. F. J. Bueche, 1969. *Introduction to Physics for Scientists and Engineers*, McGraw-Hill, New York, p. 320.
2. J. R. Howell and R. O. Buckius, 1987. *Fundamentals of Engineering Thermodynamics*, McGraw-Hill, New York, p. 167.
3. W. L. Masterton and E. J. Slowinski, 1973. *Chemical Principles*, W. B. Saunders Company, Philadelphia, p. 559.
4. International Fuel Cell, South Windsor, CT.
5. *McGraw-Hill Encyclopedia of Science and Technology*, 8th Edition, Vol. 18, p. 295.
6. *McGraw-Hill Encyclopedia of Science and Technology*, 8th Edition, Vol. 18, pp. 293-294.
7. J. C. Yater, U.S. Patent No. 5,356,484, column 5, lines 33-39.
8. J. C. Yater, U.S. Patent No. 5,623,119, column 15, lines 3-6.
9. J. C. Yater, U.S. Patent No. 5,356,484, column 9, lines 49-54.
10. J. C. Yater, U.S. Patent No. 5,356,484, column 11, lines 1-4.
11. J. C. Yater, U.S. Patent No. 5,356,484, column 15, lines 7-33.

Deuteron Dimerization Reactions Inside Metal Crystals: A Low Energy Nuclear Reaction

Talbot A. Chubb¹ and Scott R. Chubb²

We live in a time when the behavior of many-body atom systems has become a major forefront field of physics. An exciting part of this field is the development of techniques by which a collection of atoms can be made to act like a single entity, called a Bose-Einstein condensate or superfluid. Fundamental to this behavior is the idea of "particle indistinguishability." As a result of this, the particles making up the superfluid can be said to be entangled. Moreover, such an entity can be made to split itself into many pieces that are still a part of the whole.

Physicists have developed laser methods for trapping such an entity into a matrix of potential wells without destroying the coherent character of the resulting entity. The array of potential wells into which the superfluid is divided is created by forming standing waves in pairs of superposed laser beams of slightly different wavelength. Laser light is reflected back and forth between mirrors so as to form nodes and valleys of high and low electric field strength. Use of paired beams in each dimension spatially modulates the nodes and valleys, creating multi-potential well trapping regions resembling small crystals. Polarizable atoms are in a lower energy condition in the regions of high electric field. The depth of the potential wells holding the atoms can be controlled by varying the strength of the laser light. This method has permitted study of the transition of the trapped atom matter from the superfluid behavior of the Bose condensate to the particle-like behavior of normal chemistry.

In chemistry, there is always only zero, one, or other whole number of atom masses within any single potential well. In the many-body superfluid state there are usually fractional amounts of an atom in each of the potential wells, although the total amount of atom matter within the coherent volume must still correspond to a whole number of atoms. In experiments using trapped sodium atoms it has been shown that the many-body state is favored if the depths of the potential wells are small so that the particles can diffuse easily from one potential well to the next. The chemical state is favored if the wells are deep and separated from each other by high potential barriers.

This same principle presumably applies to deuterons forced into a metal. If the deuterium atoms are only weakly trapped, they should be able to spread out over the ordered volume of a small crystal. If the wells are deep, they are trapped in distinct unit cells and can only jump over the barrier to the next unit cell when they are excited by an elevated temperature condition. Because each deuteron is composed of a proton-neutron pair, one can see that once a collection of deuterons spreads out in this way, it may become possible for them to interact through a new form of nuclear interaction, which we will refer to as nuclear dimerization. We have picked this name for two reasons: 1) In these reactions, energy and momentum are transferred predominantly through the electromagnetic field, and 2)

these interactions never involve a concentrated, localized form of energy release. Because of these factors, nuclear dimerization more closely resembles the forms of dimerization that are found in chemistry than the more commonly viewed forms of nuclear bonding that are known in conventional nuclear physics.

In particular, chemical dimerization reactions are common for atoms and molecules. Well-known examples are the recombination of oxygen atoms to produce O_2 molecules and the joining of darkly colored NO_2 molecules to produce colorless N_2O_4 . The products of such reactions are called dimers. The essential ingredient for production of dimers is the existence of an attractive force between the precursor combining units.

The possibility of nuclear bonding follows from the strong attractive force that occurs between many nuclei. In conventional high energy plasma fusion, the deuteron species binds through an allowed, strong force nuclear reaction. The normal products of this reaction are $^3He^{++}$ + neutron, or triton + proton. In these reactions the released nuclear energy is carried off by a pair of high energy product particles. However, there is also the

very rare reaction path, which produces a helium-4 nucleus and a 23.8 MeV gamma ray. This rare reaction path can be viewed as a dimerization reaction in which the nuclear dimer is helium-4. The use of the term dimerization in this context is not particularly helpful because the reaction energy is liberated through a gamma ray in combination with a nuclear recoil. However, there is a parallel with chemical dimerization, in that energy and momentum are released through the electro-

magnetic field, and in the resulting reaction, all nucleons remain tightly bound. (Each proton-neutron pair in helium-4 can be viewed as forming a dimer with a second proton-neutron pair.) In dd muon catalyzed fusion a $(dd\mu)^+$ muonic molecule briefly exists following the capture of a negative cosmic ray muon μ^- in a deuterium-containing material such as heavy water D_2O . The muonic molecule is 500 times smaller than a regular molecule, which brings the deuterons into contact, allowing fusion. The helium-4 deuteron dimer is predicted to be a very rare product of muon-catalyzed dd fusion, and, as in high energy fusion, it has to be accompanied by gamma ray emission.

A form of nuclear, deuteron dimerization that more closely mimics chemical dimerization involves the release of energy and momentum, purely through electromagnetic processes at low energy, allowing the reaction $D + D \rightarrow \text{helium-4}$. This type of deuteron dimerization, namely deuteron dimerization inside a metal crystal, appears to be the most likely explanation of heat release that has been sometimes observed in heavily deuterided palladium metal. If the process occurs, it is of great importance since it points the way to massive production of energy with almost zero environmental impact. The authors see dd dimerization in a metal as a process that is compatible with present day physics. The process conserves energy and momentum, and

In the language of metal physics, the reaction is a many-body reaction involving a many-body reactant that transfers energy to a many-body fluid. Because of the many-body nature of the reaction, the reaction energy is never concentrated into an atom-size volume, but is always spread out over a many-body reactant volume.

requires no new type of force beyond those already recognized by physics. The two forces involved are the electromagnetic force and the nuclear strong force. The nuclear strong force is responsible for most of the energy release in nuclear reactions.

Nuclear dimerization physics differs from classical nuclear physics in that it involves a process that occurs at low energy, and a process which does not release high energy particles or radiation. The de-excitation of the product nuclear state occurs by multiple excitations of the electron medium of the metal host within which the reaction occurs. In high energy nuclear physics the reaction energy, which is very great, is shared typically by two reaction product particles. In low energy nuclear physics the de-excitation energy is shared typically by a billion or more electrons belonging to the electron medium of the metal within or in the proximity of the reaction volume. In the language of metal physics, the reaction is a many-body reaction involving a many-body reactant that transfers energy to a many-body fluid. Because of the many-body nature of the reaction, the reaction energy is never concentrated into an atom-size volume, but is always spread out over a many-body reactant volume. In the terms of quantum physics, this many-body volume is called a coherence volume.

When one looks at low energy nuclear physics in these terms, one sees what conditions must be achieved in order that practical nuclear heat release can occur. If the reaction is a many-body reaction, then the fuel for the reaction must be in a many-body state rather than in a particle-like state. As implied above, the electrons that carry electricity in a wire and that give metals their characteristic heat conduction properties are always part of a many-body state. In contrast, deuterium atoms, *i.e.*, deuterons with their neutralizing electron charge, are almost never in a many-body state. The reason for this electron-deuteron difference in behavior is the difference in mass between electrons and deuterons. Getting deuterons to go into a many-body state becomes the practical problem that must be overcome if one is to generate heat by nuclear dimerization.

From this line of reasoning one can see how one may be able to create the conditions for deuteron dimerization. One hopes to start off with a metal that contains many distinct small crystals, with the crystals separated from each other by regions of disorder.

The metal crystals should not too tightly bind the deuterons, otherwise the deuterons will not spread out over the crystal. A metal that absorbs heat during addition of deuterium, rather than one that releases heat, would seem desirable. Such a metal would have only shallow traps for holding a deuterium atom within a single unit cell. Instead, each deuterium atom would diffuse out of the cell and spread out uniformly over most of the crystal volume like a standing wave. When several deuterons are in the same crystal in this kind of state, they form a many-body system like that existing in the laser-trapped Bose condensate. It can be shown that in such a system the nuclear force between paired deuterons can then come into play despite the positive charge associated with each deuteron. This turn-on of the nuclear force, which is blocked by the Coulomb barrier in normal chemistry, makes possible the deuteron dimerization reaction and is consistent with the known laws of physics.

In deuteron dimerization reactions within a metal, the nuclear forces and the electromagnetic forces are coupled in an unusual way. This coupling is implicit in quantum mechanics. Two deuterons spread out over the same volume of crystal in identical ways have a different volumetric charge density distribution when existing as deuterons than they do when they are combined into a helium nucleus spread out over the same crystal volume. The electrons that provide charge neutralization respond to the changing charge density distribution. The resultant coupling causes a nuclear-force-induced change to excite the electron medium, transferring bits of energy out of the nuclear system. Fast step-wise flow of energy into the electron system occurs within a reaction interval, removing excess energy from the nuclear product (helium-4) state and heating the metal.

Deuteron many-body matter follows the accepted rules of reaction rate physics, which permits calculation of a theoretical rate of heat release from dimerization reactions. The reaction rate of each coherence volume varies as the square of its ratio of coherent deuterons to metal atoms. Calculated rates for an idealized matrix of small crystals exceeds 1.0 kW/cc for a coherent deuteron/metal ratio of 0.001. Such rates of energy release exceed the peak heating rates that have occasionally been observed in the palladium deuterium system.

About the Authors:



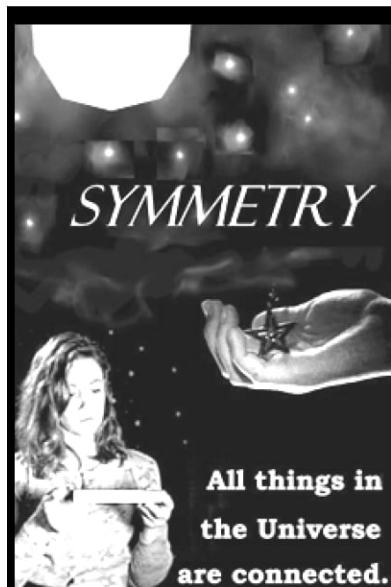
Scott Chubb received his B.A. degree in physics from Princeton University in 1975 and his M.A. and Ph.D. degrees, also in physics, from the State University of New York (SUNY) at Stony Brook, in 1978 and 1982 respectively. From 1982 to 1989, he worked on problems associated with theoretical solid state physics at Northwestern University, in Evanston, Illinois (1982-1985), and, while in residence at the Naval Research Laboratory (NRL), first as a National Research Council Fellow (1985-1988), and then as an employee of Sachs/Freeman Associates, Inc., of Landover, Maryland (1988-1989). Beginning in 1988, he also began work in areas related to applications of microwaves in space technology at NRL. He became an employee of NRL in 1989. Besides being a permanent NRL employee, concurrently, he has held consultant positions with Research Systems, Inc. (in Arlington, Virginia) since 1990, and Oakton International Corporation (in Oakton, Arlington, and Burke, Virginia) since 1995, in areas related to Cold Nuclear Fusion. He has been an author of more than fifty refereed publications in scientific journals, in areas related to solid state physics, general and special relativity, electromagnetic scattering, non-linear wave dynamics, statistical physics, and nuclear physics. He also is an author of one patent, which was awarded in 1996.

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Talbot Chubb received an A.B. in physics from Princeton University in 1944 and a Ph.D. in Physics from University of North Carolina (Chapel Hill) in 1951. He retired from the Naval Research Laboratory in 1981. In 1978 he received the NAVY Distinguished Civilian Service Award. He is a Fellow of the American Physical Society and of the American Geophysical Union, and a member of the American Astronomical Society. His work has included gas discharge studies, space physics and astronomy, and energy studies involving thermochemical energy transport and "cold fusion." He has been author or co-author of 70+ refereed scientific papers, which include laboratory studies, data interpretations, and theory.

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“Cold Fusion Night at the Movies”

by Eugene Mallove



Top: “Carolyn” and “Klinger” face off in “Breaking Symmetry.” **Middle:** Actress Linda Amendola (“Carolyn”) with Keith Johnson* **Bottom:** The actor who portrays the evil “Klinger,” Archer O’Reilly, needs no persuading about cold fusion from Gene Mallove.* *Photos: Ed Wall

Some 250 to 300 souls made their way on May 26 to a large ballroom in the Cambridge (Massachusetts) Marriott Hotel to experience “Cold Fusion Night at the Movies”—the Boston-area premier showing of two frontier films, both with cold fusion themes. On a clear, bright evening, beginning at about 6:00 p.m., the elegant room began to fill with area students, a scattering of professors from MIT and elsewhere, cold fusion and new energy researchers, New England-area *Infinite Energy* subscribers, and cognoscenti of New England-area film-making.

The venue was at the very perimeter of the sprawling MIT campus. Not on campus, mind you, but at its edge; in the past we had had quite enough of hurdles and problems associated with having anything so heretical and threatening to the MIT establishment as discussions of cold fusion. It was easier to simply rent a room at the very accommodating Marriott Hotel. Seating was provided at no additional cost for 600 (beyond the nominal target of 400), in the event an overflow crowd arrived. The organizers were even prepared to run a second showing, had there been a standing-room-only crowd, with a line of folks queuing up who could not get in.

Shown successively on a massive, imposing 9 x 12 foot rear projection screen draped in blue were MIT Professor (retired) Keith Johnson’s 90-minute techno-thriller *Breaking Symmetry* and *Infinite Energy*’s own 70-minute video documentary, *Cold Fusion: Fire from Water*. Both films were projected at high-luminosity from digital tapes. The stereophonic sound system was of Bose components. From a booth inside, *Infinite Energy*’s staff sold books, magazines, and the newly-packaged video.

“Cold Fusion Night at the Movies”



This may well have been the first time in film history that both a documentary film and a fictionalized film treatment bearing on the subject of the documentary were shown on the same venue near the time of both films’ debuts.

Posters in the hallowed halls of MIT and in stores and film-oriented niches in the Boston area had for some weeks advertised this “Cold Fusion Night” event. One imagines the dismay or glee of the naysaying MIT professors who might have glanced at the numerous posters that read:

“Enjoy an unprecedented Cold Fusion film double-header with this Boston area premier presentation of works by MIT Professor Keith Johnson and distinguished MIT alumnus Dr. Eugene F. Mallove.”

“Professor Johnson’s feature length thriller *Breaking Symmetry* will entertain as surely as Dr. Mallove’s documentary, *Cold Fusion: Fire from Water*, will educate on this controversial and often misunderstood field. Please join us for an evening of fun and enlightenment!”

The admission fee was a bargain (certainly by *Star Wars* standards) — only \$5.00, with free admission for students with college ID’s.

Cold Fusion: Fire from Water had earlier (April 29) been introduced to an audience in the Washington, DC-area

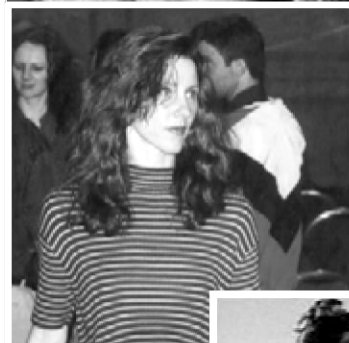
at the Bethesda, Maryland *Conference on Future Energy*. Producer-Director Christopher Toussaint of Free Spirit Productions then had introduced this video to the receptive and appreciative audience.

Some of the lead actresses and actors in Professor Johnson’s movie attended “Cold Fusion Night,” as did some of those who had worked hard on the film. Prof. Johnson and his architect wife Franziska Amacher (a co-producer of the film) had returned only the day before from the Cannes Film Festival in France. There *Breaking Symmetry* had been showcased. Distribution in the U.S. for *Breaking Symmetry* is still being negotiated as are foreign distribu-

tion rights. Professor Johnson has expressed some interest in the home video market, but he is more attracted to the idea of theater distribution first.

Unlike *Breaking Symmetry*, anyone can today purchase *Cold Fusion: Fire from Water* and view this documentary in the comfort of their home.

Both films touched, in small part, on the delicate



Photos starting from the top: Cecilia Johnson as "Nicole"; Archer O'Reilly ("Klinger"), Cecilia Johnson ("Nicole") and Keith Johnson celebrate the movie's opening; Cecilia Johnson; Rivals "Nicole" (Cecilia Johnson) and "Carolyn" (Linda Amendola)

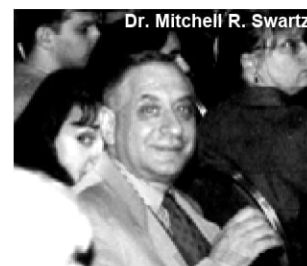


matter of fudged data in a 1989 cold fusion experiment performed by an "Institute" in the Boston area. In *Cold Fusion: Fire from Water*, the allegation is explicitly tied to the MIT Plasma Fusion Center Group's farcical experiment that was only analyzed (and fudged to look "null") after a "Wake for Cold Fusion" party had been held (see *IE* issue No. 24.) Though Johnson's film mentions such fudging and, in fact, depicts the very fudged curves that Eugene Mallove had revealed, the setting of his story is at a famous Boston area "Institute." His self-funded production was shot both at Boston's Wentworth Institute of Technology and in the surrounds of MIT—so it is not clear which "Institute" is referenced, even as a fictionalized locale. However, it must be said that Wentworth has no fusion laboratory, to my knowledge!

Dr. Mitchell R. Swartz of the *Cold Fusion Times* attended "Cold Fusion Night," bringing with him an armload of his newly published book, *Fusion and Other Nuclear Reactions in the Solid State: Vol. 2. Calorimetric Complications* (see ad page 12). This excellent work, replete with revealing color graphics, deals with the contested MIT PFC calorimetry experiment of 1989. In his book, MIT graduate Dr. Swartz states of the key offending MIT PFC published figure, "The graph should be retracted because of its prolonged—and unwarranted—negative impact on science

and engineering in the United States of America."

Some interesting background to all this: When MIT Prof. Keith Johnson asked for a response to his request to film *Breaking Symmetry* on the MIT campus, his requests were totally ignored by the MIT authorities—even though the MIT News Office and an aide to MIT President Vest had been given a script of the film in advance.



In honor of the Marriott showing and the promise to donate net proceeds to a Student Cold Fusion Research Fund, a \$500.00 check has been sent to the MIT Department of Electrical Engineering and Computer Science, even though the sales of tickets to the event did not exceed the expenses to put it on. Perhaps EECS Professors Hagelstein and Smullin, who are involved in cold fusion investigations, will help direct this small fund. The explicit instructions accompanying the gift are that this

donation is to be used to offset the cost of supplies for students wishing to conduct cold fusion experiments. Since at least twenty identifiable MIT students attended the showing on May 26, there is certainly a local opportunity. Students attending also included those from Harvard, Brown, Northeastern University, UMASS and Worcester Polytechnic Institute (WPI).



Franziska Amacher, Co-Producer, wears the necklace that appears in the beginning of the film.

Soon after the May 26 event in Cambridge, and on much shorter notice, Eugene Mallove was invited to lecture and show *Cold Fusion: Fire from Water* at the Georgia Institute of Technology in Atlanta. This he did on June 2 at GIT's student center. A much smaller audience attended (about twenty students and professors), but

the invitation was much appreciated. Perhaps from now on cold fusion events on or near campuses should not be held at the end of the academic year, when students' thoughts are on graduation, passing examinations, and generally winding the term down.

Mallove was told by the GIT cold fusion event organizers that these Lyceum Series lectures (run by a committee of the Student Government Association) had recently included ex-Clinton Administration spokesperson George Stephanopoulos (promoting his multi-million dollar tell-all book), controversial TV show host Jerry Springer, comedian Tommy Davidson, and even sex advisor "Dr. Ruth" Westheimer, whose popular topic might be said (loosely) to fall within the area of *hot* fusion. Those lectures were mobbed. Seeming to command more interest than *Cold Fusion: Fire from Water* was the John Travolta movie, "Primary Colors," which was playing over the common area cable feed in the GIT student center outside the lecture hall where Gene Mallove spoke. Let's face it, cold fusion just doesn't get the easy breaks! It is a difficult road to follow, no matter what well-executed artistic productions our field has to offer. ★★★

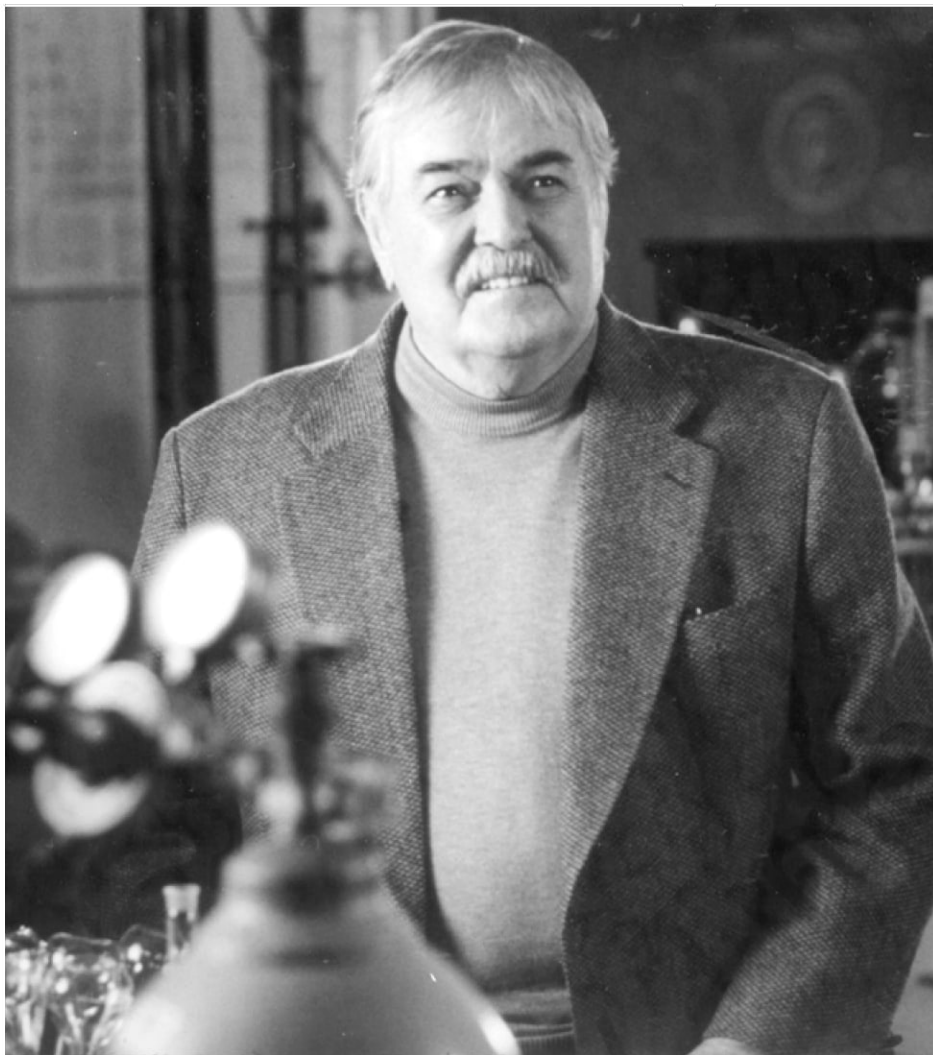
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Reaching the New Energy Frontier

AN INTERVIEW WITH
**JAMES "SCOTTY"
DOOHAN**

Jeffery D. Kooistra

Photos by Gene Kirkland

The generation of scientists and engineers that put us on the Moon was heavily influenced by the science fiction of the Golden Age—those stories that appeared in pulp magazines in the 30's and 40's. But for those scientists and engineers who came later, after the pulp era had passed, there was TV.

The 60's was a great time for TV science fiction. There was "The Twilight Zone" and "Time Tunnel" and "Voyage to the Bottom of the Sea." There was "Lost in Space" and "The Outer Limits." But most of all, there was "Star Trek."

"Star Trek" was special. For the would-be swashbuckler, Captain Kirk provided a role model. For women, there was Mr. Spock—tall, dark, mysterious, and unattainable. But for us would-be engineers, there was Chief Engineer Montgomery "Scotty" Scott, of the Starship Enterprise, the finest engineer in the whole Star Fleet.

Scotty was my personal icon. Let Kirk deal with the monsters and the women of the week. Let Spock go around being logical. When I watched "Star Trek," I wanted to know what was going on in the engine room. I wanted to keep that warp drive working. I wanted to troubleshoot the transporter. I wanted to be with Scotty fighting his way through electrical discharges in the Jeffries tube to save the day.

It is James Doohan who gave life to Scotty. In the show, it was always clear that Scotty loved the technology that had been entrusted to him. During my brief interview with Mr. Doohan, it became clear to me, as it will to you, that here was a man who also has an ongoing love affair with science and technology.

No wonder so many of us scientists-and-engineers-to-be wanted to be like Scotty—James Doohan, it turns out, was one of us.

Infinite Energy (IE): Do you recall hearing about cold fusion back in 1989 when the story first broke?

James Doohan: Yes and I was very excited about it and I couldn't believe what happened, you know. After awhile, the thing with the government and the poo-pooing from some so-called experts was just too much for me. And, of course, ten years later, I was just thrilled to have Chris [Toussaint] call me and do the job for him that I did on video.

IE: Were you aware that there was still ongoing research happening even though it. . .

James Doohan: Not really, no. I read science magazines an awful lot, but I didn't hear much about it.

IE: That explains it.

James Doohan: I'll tell you, I am just terribly excited with the script that Chris [and Eugene Mallove and Jed Rothwell] wrote because it fills me in with all the different people around the world, scientists who are working on it, including Chinese and Indians and Japanese.

IE: Did it come as a surprise to you that scientists could be as rabid as they were in attacking the cold fusion work?

James Doohan: Oh, absolutely. I was horrified at this because I believed that Fleischmann and Pons had done it. I believed they had done it.

IE: You were right. It turns out they had done it.

James Doohan: What shocked me, my manager called me up one day and told me that I was going to do a video on "Cold Fusion: Fire from Water" and I couldn't believe it. I couldn't wait to get there and start working on it.

IE: Oh, we were delighted to have you.

James Doohan: Well, I was always... I used to get 100% in physics and chemistry and mathematics (well, maybe a couple of points off in mathematics), and that was in high school. Of course, the war came along and I was in the Army for six years and two months and I landed on D-Day, number one off on my beach.

IE: Really?

James Doohan: Yes, and was in charge of my LBA when I was an artillery officer and got in my commission in England. So, I started out as a Private and ended up as a Captain. So, to me, it was always very exciting to do things like that.

IE: Is it conceivable that if the war hadn't come along you might have gone into science?

James Doohan: Oh, absolutely. As a matter of fact, in a strange way... I talked to my older brother, who is now a retired Canadian army general. I talked to him and he was a full colonel at that time, after the war, and I said, "What do you think I should do?" And he said, "Well," he said, "the veterans administration, because of your service. . ." (because I was five and a half years overseas and that's double-time). He said, "The veterans administration in Canada owes you nine years of training and education." "So," he said, "Why don't you go to the veterans school and bone up on subjects that you haven't had for seven years?" And I thought that was a good idea so I moved to London, Ontario from Sarnia, Ontario, which is sixty miles west of London. It was a fluke that between Christmas and New Year's of 1945 and 1946, I put my books down, turned on the radio and heard the worst drama I had ever heard, ever. It got my dander up because I had done some speaking and a little bit of acting.

The thing was, I went down to the local radio station and made a recording and listened to it. The

first time I had heard my own voice, and I was disgusted. Everybody is also disgusted I find out. I told the operator about that and he says, "What are you talking about? You're good." I said, "Well, where do you go to learn?" Happenstance was that I—that the radio station—had received a brochure that morning in the mail of a drama school that was opening in Toronto for veterans and anybody else who wanted it. So, I got their address, sent them a wire, and got an answer back an hour and a half later. I was there going to their opening the following Monday and I won a two-year scholarship to the neighborhood playhouse, which, at that time, I didn't know anything about drama schools. But I won this scholarship to New York and, subsequently, I did my two years there and then was the assistant to the teacher for three years after that. In the meantime, of course, I was on television the very first Tuesday of television and then, of course, it excited me. I was on one of the very first color television [shows], which happened to be "Peyton Place," "Star Trek," and "Voyage to the Bottom of the Sea."

IE: Do you think we are going to witness the coming of this new energy age?

James Doohan: Oh, absolutely. I'm quite sure. I hope that it's done in my lifetime. I'm seventy-nine years of age now, but I hope that it's done. It excites me to think more about it. I was just thrilled.

IE: How scientifically aware is the Hollywood community?

James Doohan: I think there are a lot of people who are aware of scientific things that go on and I think they are going to be as proud of me as I am of myself for getting the job. I think there's an awful lot of really good thinking brains down there.

IE: So, you think that the people in Hollywood could be made more aware of the situation that's been going on in cold fusion since the beginning?

James Doohan: Oh, yes. Thank God, the video that I did is going to help. I think that they're all going to be jealous of me for getting that job.

IE: Oh, good. We're glad to hear that, believe you me. . . Hollywood supports all sorts of causes, from conventional party politics to animal rights, human rights, and AIDS research. Do you think it would be possible to start a groundswell of opinion and financial support for cold fusion research in contrast to commercial investment within the Hollywood community?



James Doohan on location of *Cold Fusion: Fire From Water*, Chris Touissant (above right), Free Spirit Productions.

James Doohan: I don't see any reason why that shouldn't be done, but I'm just not the person to do it.

That's all right, Mr. Scott—you've done your part. James Doohan was the perfect choice to narrate *Cold Fusion: Fire From Water*, for the physics of cold fusion really is of a kind that lies beyond the cutting edge. The new energy age will be a period when "Treknology"—that is, technology one might now only expect to find in "Star Trek"—is ubiquitous. It was always clear in every episode of "Star Trek" that the future is a place of abundant hope and infinite energy.

☆☆☆

The Perennial Challenge of Anomalies at the Frontiers of Science

Beverly Rubik*

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Abstract

The history of science is full of rejections of novel discoveries that challenged the dominant paradigm. The reasons for rejection on the part of the scientific community are discussed. Nonetheless, scientific anomalies are crucial to promoting continuous scientific innovation and breakthroughs. The most challenging anomalies are recognized only after a reasoned explanation has been offered and accepted. Many of these anomalies come from the "frontier sciences," areas of scientific inquiry that are not yet mainstream. The extraordinary obstacles that frontier scientists face are elaborated. In light of this, strategies are offered toward progress, particularly for research in homoeopathy and low dose bio-effects.

Several frontier areas of research in biology and medicine relate to the subtler features of life that seem to defy explanation by conventional molecular mechanism. Frontier scientists working in the areas of consciousness studies, epigenetic inheritance, certain topics in bio-electromagnetics, and homoeopathy and other low dose bio-effects offer science the gift of new questions that go beyond the dominant paradigm of mechanical reductionism. Often regarded as isolated anomalies by the mainstream, the results of their investigations taken collectively show the need for a larger paradigm to accommodate them. Biology appears to be entering a crisis. Whereas conventional science maintains that biological information is stored and transferred via biomolecular structures such as DNA, the novel frontier findings suggest that other informational signals not attributable to discrete chemical structures may elicit biological effects. These signals may be interacting with a more subtle bioregulatory system that is a property of the whole organism, such as its endogenous electromagnetic field.

Introduction

Scholars have documented the resistance to novel scientific discovery by various groups, such as economic and religious groups. However, there has been less attention given to the resistance of the scientific community itself to challenging scientific discoveries.¹ Nonetheless, we find it in the history, philosophy, and sociology of science and especially in the writings of scientists who have personally suffered obstacles due to this resistance. The scientific community believes that it deals with novel controversial discoveries in a rational manner, yet this is rarely the case.

The history of science, medicine, and technology is full of rejections of novel discoveries that seemed anomalous in their time. Contemporary scientists laughed when Benjamin Franklin proposed that lightning was a form of electricity. Semmelweis, a Viennese physician who documented that washing one's hands before obstetrical assistance would prevent childbed fever, was scorned and rejected by his contemporaries. William Crookes, the noted British scientist and member of the Royal Society who discovered the element thallium, was bitterly attacked by his scientific colleagues for his research in parapsychology. Lord Kelvin said that X-rays were a hoax.

Helmholtz, who was not a physicist, but a physician who formulated the theory of energy conservation and who was opposed by the physicists of his time, noted how the "greatest benefactors of mankind usually do not obtain a full reward during their lifetime."² Lister warned medical students against

The history of science, medicine, and technology is full of rejections of novel discoveries that seemed anomalous in their time.

blindness to new ideas in science, such as he had encountered against his own theory of antiseptis. Long after their time, many of these scientists whose ideas were rejected were regarded as formative thinkers who made significant contributions or even launched new scientific paradigms.

The Scientific Paradigm

In 1962 Thomas Kuhn published a seminal work, *The Structure of Scientific Revolutions*,³ which addresses the manner in which science advances. Kuhn's main thesis is that science is not a slowly growing body of knowledge approaching a true description of the world. Instead, science is characterized by periods of quiet research activity leading to a crisis, which may last for years to decades. During this transition period, scientific problems appear that cannot be resolved within the given paradigm. Scientific anomalies, experimental results that cannot be reconciled with current theory, may occur. Such anomalies are critical to progress in science. In fact, each new major advance in science starts with an anomaly that is unacceptable at first.⁴ Therefore, anomalies are valuable because they inspire new ways of thinking. Conventional scientists attempt to explain the anomalies within the framework of the dominant paradigm, while a smaller, usually younger group of scientists develop an alternative paradigm. The crisis is resolved by a dramatic change of perspective, a paradigm shift. A struggle typically ensues that may result in the overthrow of the old paradigm. After the triumph of the new paradigm, the old paradigm eventually disappears in a time frame necessary to provide stability and confidence in the new paradigm. What was an anomaly earlier now becomes the expected result. Textbooks are rewritten in such a way that they even disguise the very existence of the revolution that generated them. Eventually, new research uncovers problems with the new paradigm. Then the process repeats itself.

Kuhn noted how unconsciously ingrained the dominant paradigm is. He wrote: "Scientists often work from textbook models acquired through education and through subsequent exposure to the literature without knowing or needing to know they are accepting a community paradigm."⁵ They work to fit their data into the ruling paradigm. The usual peer review process in science provides an adequate forum for evaluating new ideas



and discoveries, but this is only true if those ideas and discoveries do not challenge the paradigm. As was mentioned previously, those considered incomprehensible or too challenging to current scientific understanding are typically rejected. Michael Polanyi, in defending this conservative nature of science wrote: "There must be at all times a predominantly accepted scientific view of the nature of things, in the light of which research is jointly conducted by members of the scientific community. Any evidence which contradicts this view has

to be disregarded, even if it cannot be accounted for, in the hope that it will eventually turn out to be false and irrelevant."⁶ Although the neglect of other possible conceptual categories is not malicious in intent, it can become malicious in effect because the dominant paradigm discourages, and is intolerant of, competitors. That is, scientists prefer their work to appear as an integral, growing body of knowledge under the auspices of a single paradigm. Perhaps this is because scientists are encouraged to demonstrate what they know rather than to raise truly novel questions that challenge what they think they know.

Kuhn recognized an "essential tension" within science because it must preserve its accumulated knowledge by acting cautiously and conservatively and on the other hand remain an open system ready to take in novel, potentially revolutionary data and concepts.⁷ This balance is maintained in a number of ways. In the first place, science places the burden of proof on those who claim to discover scientific anomalies or otherwise make revolutionary scientific claims. Secondly, the proof must be commensurate with the claim; that is, extraordinary claims require stronger than usual proof. (This relates to the principle of parsimony in science, in which the simplest adequate theory is the most acceptable.)

It is interesting to note that Kuhn believes that science generally progresses in a positive direction,⁸ but that some paradigm shifts have reversed concepts such that aspects of an even older paradigm may return in the form of new input, reshaping old models.⁹ It is a common conviction that the world is progressing in one direction scientifically and socially, but as Kuhn points out, very often the clock is turned back with new scientific developments. For example, relativity and quantum theory, two of the most significant scientific paradigm shifts in the 20th century, both turned back the clock in certain ways. The gravitational aspects of Einstein's general relativity reflect back to Newton's predecessors, and quantum mechanics has reversed some of the methodological prohibitions that had occurred in the earlier chemical revolution. Needless to say, the reshaping of older views into a new paradigm would have significance for homoeopathy and low dose bio-effects. Many scientists today have the attitude that these phenomena from an era predating modern molecular biology have been overthrown, or that at best they represent a placebo effect. These scientists are victims of historicism who refuse to accept anything from an earlier time as bearing any modicum of truth.

Scientific Anomalies

According to science sociologist Marcello Truzzi, an anomaly is something that:

- actually occurs (that is, something both perceived and validated),
- is not explained by some accepted scientific theory,
- is perceived to be something which is in need of explanation,
- contradicts what we might expect from applying our accepted scientific models.

I would suggest that the anomaly's lack of fit with accepted theory is the necessary element common to any real anomaly. It is a fact in search of an explanation.¹⁰

In the field of anomalistic observations, or anomalistics,¹¹ that is, enquiry into anomalies and their role in science, there are different types of scientific anomalies, at least in retrospect. There are those that are recognized in their time by the scientific mainstream and become the subject of legitimate research activity, and those that go ignored by the mainstream because they are apparently too threatening. Many of the latter come from the "frontier sciences," that is, whole areas of scientific enquiry that have not yet been incorporated into conventional science. These areas are ignored or even considered irrelevant by the mainstream, in some cases because they are often residues of older systems of knowledge that have been denounced as pseudoscience as, for example, parapsychology and astrology.

The history of science shows that the most challenging anomalies, those that seriously challenge the dominant paradigm, are

One of our best strategies would be to serve as mentors and inspire younger scientists to conduct research in novel areas of science.

ignored by the scientific mainstream until they are explained, and only then are they recognized in retrospect. The term retrorecognition has been given to this type of recognition which is given only after there is a compelling explanation for the anomaly.¹² Such anomalies make the scientific community uncomfortable, as it likes to think of science as an integral body of knowledge that is nearly complete. These unexplained facts are either ignored, reduced in importance, or merely accepted as "givens." Several factors are behind this attitude, such as the sheer intellectual difficulty of recognizing anomalies, the tendency to ignore a problem that cannot be easily solved, and the conservatism of science. But there is something more. The recognition of what were once anomalies under an older paradigm only after they are reconciled with a new paradigm clearly shows that the scientific community is unable to live with ambiguity and cognitive dissonance (psychological inconsistency). However, frontier scientists whose work challenges the paradigm appear to be of a different psychological makeup, with a higher tolerance for ambiguity and cognitive dissonance. It is interesting to note that such tolerance correlates highly with creativity scores in psychological testing.¹³ Furthermore, frontier scientists may be working from dimensions other than rationality and logic, for Kuhn has written, "The man who embraces a [new] paradigm at an early stage must often do it in defiance of the evidence. . . A decision of that kind can only be made on faith."¹⁴

The Role of Skepticism

Indeed, it is rare to find scientists who are true skeptics, that is, without prejudice, open, and tolerant of uncertainty. It is unfortunate that the term "skeptic" is being used by many who are disbelievers or debunkers whose aim is to remove the anomaly, rather than true nonbelievers.¹⁰ This appears to be particularly the case for organized so-called skeptics groups such as the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP), which sponsors unusual critiques and other activities to discredit anomalous scientific claims, undermining the usual processes of replication attempts and peer review. In some cases this has involved members outside of the scientific community, such as professional magicians, in a

process analogous to inquisitors for a dogmatic church.¹⁵ Unfortunately, this has the effect of creating fear among those who would have an interest in trying to replicate the anomaly, thereby blocking real scientific enquiry.

Where there are anomalies and frontier areas of science that seriously challenge the paradigm, the scientific community is often polarized into two categories: believers and disbelievers. Although the scientific community may consist largely of disbelievers, sometimes the frontier scientists or proponents of an anomaly act as "true believers." In some cases there are societies of "true believers" centered around maverick scientific claims that do not welcome open dialogue. In my opinion, they are no better than some of the mainstream scientists they criticize. Sometimes the discoverer of a challenging fact overstates his claims, jumping to conclusions about the importance of his discovery without adequate data. On the other hand, the "essential tension" of the scientific process renders it very difficult to find

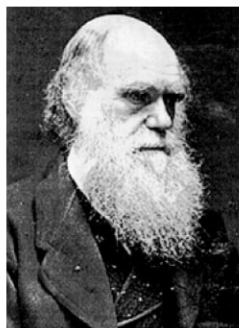
...each new major advance in science starts with an anomaly that is unacceptable at first.

the right balance in reporting anomalous claims. If the discoverer understates his claim, it may go ignored; if he stresses its revolutionary character, it may gather more attention and resources for further study. From my own work aiming to facilitate new research and greater open-mindedness in frontier areas of science, I find that it is difficult to stand firm on the fine line that separates the believers from the disbelievers. In my opinion, this is the best viewpoint to encourage an attitude of nonbelief that stimulates new questions and further experimentation. Apparently this viewpoint is not well understood or liked by most, as I am often accused of being "the enemy" of one group or the other. However, openness and a healthy level of skepticism are crucial in order to avoid pathological science.

The Power of New Questions and Approaches in Science

Scientists must approach nature by asking questions of her, and it is impossible to pose a question without some expectation or anticipation. Clearly, from the analysis of Kuhn and numerous other scientific historians and sociologists, science is not context-independent. Scientific objectivity does not reside in theory-free perception. It lies in the flexibility to reject a cherished theory when an anticipated observation cannot be confirmed, and a contrary event or fact is perceived instead. Scientists may say that they see the data with their own eyes, but in fact, they see it through their brains. They cannot bypass this central focus and filter full of biases, products of both evolution and society. It is very difficult to "see" scientifically beyond the context of theory or expectations.

As an example, consider the following. Before Darwinism, the paradigm that preceded evolutionary theory was natural theology, in which each creature was considered to be perfectly adapted to its environment and designed for full functionality. While natural theology dominated, no one noticed that some organisms were less well-adapted to their environment. Natural theology would not permit such questions. Ducks with webbed feet that could not swim, birds with wings that



Darwin. Photo by: Julia Margaret Cameron, 1815-1879

could not fly, and bats with eyes that could not see, went unnoticed. Darwin asked new questions and noticed that some animals were less well-adapted for their environment. He explained these anomalies on the basis of natural selection, an ongoing evolutionary process. The point here is to show the power of asking new questions that take us outside the present scientific theory or paradigm. These offer the possibility of a breakthrough to a new way of seeing nature. As physicist Werner Heisenberg noted, "What we observe is not nature itself, but nature exposed to our method of questioning."

Another historical example of this goes back to microscopy of the 17th and 18th centuries. The great microscopist van Leeuwenhoek and his contemporaries claimed they saw minute forms of complete babies inside sperm under the microscope. Their observations were shaped by the 2000-year-old idea that women contributed nothing to conception but the womb as an incubator. In this case, too, preconceived ideas determined what was scientifically observed.



Antoni van Leeuwenhoek. The picture was first published in his book, *Arcana Naturae detecta*, in 1693.

In another historical example involving microscopy, different methodological approaches of observation based on different philosophies led to a scientific debate. In the 1940s the bacteriologist Adrianus Pijper maintained that bacterial flagella are not true motor organs, but are essentially insignificant, being merely cell wall by-products of bacterial motility.¹⁶

From his observations of live bacteria under the dark-field microscope, he claimed that he saw small changes in the body forms of the bacteria, a slight undulating motion, which he proposed as a theory of bacterial motility. As it turned out, his view was unpopular because he was far outnumbered by those who fixed and stained dead bacteria for light microscopy or electron microscopy, which was newly introduced at that time. The majority of scientists then claimed that flagella were indeed the organelles of motility and showed evidence via microphotography of sites of flagellar attachment to the cell body. Pijper rejected these physical approaches, emphasizing that studies on the living state itself were critical to understanding cellular motility, and that the approaches using dead cells might yield artifacts. This led to an ongoing debate, as both schools refused to "see" any evidence beyond their own viewpoints. In the end, Pijper lost the debate. His refusal to acknowledge the "superiority" of the electron microscope was held against him by the scientific majority.

Beyond the specifics of this historical debate, the latter case is important for us to consider because it reveals the perennial struggle between the naturalist and the mechanist in biology. It shows how naturalists' observations of living systems were replaced by a modern biology tightly linked to physicochemical reductionism as new powerful, expensive, prestigious, technological tools came into being. These new physical methods require an often insensitive manipulation of organisms that distorts or even kills them in order to study them. The naturalists' approach came to be regarded as old-fashioned and even reminiscent of vitalism by the new biologists, who were led by several physicists-turned-biologists in the 1940s and 1950s. These were the people who ushered in a new scientific era, the revolution that became the dominant paradigm of molecular biology and biotechnology in recent decades.

Resistance of Scientists to New Discoveries

Studies on the psychology of science suggest that scientists have a resistance to acknowledging data that contradict their own hypothesis.⁶ In one study on falsifiability, a simple experi-

ment was set up to compare the performance of a group of scientists and a group of clergymen. A false hypothesis was given to all the participants. The means was provided for them to test the hypothesis, which they did not know was false. The results showed that most of the scientists refused to declare the hypothesis false, clinging to it longer despite the lack of evidence. The clergymen, however, more frequently recognized that the hypothesis was false. This and other studies show that scientists are at least as dogmatic, authoritarian, and irrational as non-scientists in resisting unexpected findings.

The historical examples cited earlier illustrate only a few reasons why resistance to novel discoveries in the scientific community occurs. Analysis of many other examples shows numerous ways in which scientists resist discoveries that are old paradigm breaking and new paradigm making. One of these mentioned earlier is the loathing of ambiguity. Most scientists prefer to elaborate what they think they know rather than focus on what they do not know; perhaps this is simply human nature. Along with that is fear of novelty. New discoveries require restructuring older ideas and ways of doing science. Change, whether it is personal, social, or intellectual, is difficult and may even cause a lifetime of work to become unimportant and obsolete. Related to this is the fact that older scientists have a tendency to resist the novel work of the younger. Innovative "outsiders" may also be rejected by the "insiders," especially if the new discovery comes from outside the field, as in the case of cold fusion.¹⁷ There is also a faithfulness to old models, reflecting a belief in scientific concepts or simply conservatism. When Thomas Young proposed a wave theory of light, the scientific community remained faithful to the older corpuscular theory for some time. This tendency sometimes reveals a dogmatism or scientism. Paul Feyerabend accuses contemporary science of being a "church" in which scientists play a role that is in many respects similar to the role bishops and cardinals played not too long ago.¹⁸ Another mode of resistance, also illustrated by the example cited earlier of van Leeuwenhoek and his colleagues, is blindness due to preconceptions. It is extraordinarily difficult to "see" what may lie beyond one's paradigm, which delimits all questions posed of nature and ways of perceiving her. Anomalies without "causes" or an adequate explanatory model are rejected because they do not fit neatly into the body of science. If an anomalous claim pertains to an area reminiscent of mysticism, religion, older paradigms that have been overthrown, or pseudo-science, this may be grounds for rejection by those who feel threatened by these associations. Occasionally conflicting personal religious ideas may be another reason for rejection. That was the case for both Galileo and Copernicus, and it also appears to be a factor in the debate between creationists and evolutionists. Scientists evaluating an anomalous finding sometimes take into account the relative professional standing of the discoverer as well as the number of prestigious followers of the new claim, and these are primarily political concerns. Concerned

about their reputation, scientists are reluctant to take the lead in helping to advance a new claim. In relation to this, publications about the new scientific claim in other than the most prestigious peer-reviewed journals are taken less seriously and may be grounds for rejection or simply neglect. Finally, and perhaps most



Galileo



Copernicus

important to contemporary science, it is true that where substantial funding is involved, patronage to those ideas endorsed and funded to the exclusion of others is overwhelming.

Today, because of large economic interests in science, biomedicine, and technology, and the increasing overlap between academia and industry, the resistance to new discoveries or ideas that challenge the dominant paradigm goes well beyond ideological concerns. Challenging ideas can be seen as threatening to big business interests, including the interests of industries waging war against cancer or AIDS. Anyone who is a proponent of ideas that threaten large-scale economic interests can expect even harsher backlash from the scientific community, which in mainstream biology and medicine is now closely linked to pharmaceutical and biotechnology firms. Surely that is one of the most significant reasons for rejection of novelty in biology and medicine today. Moreover, the many different fields of biology with their varied orientations to life that existed before big business science are presently extinct, at least in the U.S.

It is simply taboo to offer a serious challenge to the dominant paradigm, and those who propose such maverick ideas or findings suffer extraordinary obstacles. Similar to the acceptance of novel discoveries, the obstacles are especially severe for those whose work threatens big economic interests that are now coupled to mainstream science.

Obstacles Faced by Scientists Who Challenge the Paradigm

There are a number of serious, even extraordinary obstacles that scientists presently face as proponents of paradigm-challenging discoveries or where their reputation becomes associated with research on unconventional topics. These obstacles are not characteristic of a particular culture; they appear worldwide. These are:

- difficulty in obtaining funding, as there are simply no usual sources
- difficulty in publishing, and there is no *real* peer review
- loss of camaraderie (colleagues fear a loss of reputation by association with a scientist who is deemed an outcast)
- loss of reputation in the scientific community regardless of one's stature
- obstacles to promotion, retention, and tenure
- possible critical backlash from the scientific community
- possible loss of employment and future employment opportunities

The pursuit of research in frontier science areas such as homeopathy and extremely high dilution bio-effects, novel medical therapies or diagnostics, new energy technologies, and consciousness studies—research in any area that challenges the dominant paradigm—presents extraordinary hardships for scientists. Merely expressing an interest in these can affect one's reputation as a serious member of the scientific community. Whether one is a post-doctoral researcher, a junior professor, a member of a distinguished national academy of science, or a Nobel laureate, essentially the same obstacles remain. For those who have seemingly overcome these hurdles, publication of challenging scientific results may bring about unforeseen backlash in the form of discrediting the discoverer or the claim without really disproving it, prohibiting it from being tested by others. Moreover, this may prevent consideration of similar challenging claims in the scientific literature, textbooks, and education. The proponent of the anomalous claim is thus isolated from further debate and interaction with the rest of the scientific community.

Many people associate such repressiveness with earlier times, but there are living examples today. One illustrious example—a case where big economic interests in biotechnology and medical testing are threatened—is that of Peter Duesberg, Professor of molecular biology at the University of California at Berkeley. His work identifying the first oncogene to cause cancer and also

decoding the first retrovirus genes earned him an outstanding international reputation as a molecular biologist and virologist. However, because of his recent criticism of the oncogene theory of cancer and especially his criticism of HIV as the cause of AIDS, he has essentially been silenced by the scientific community. No one will debate his arguments either in writing or in person. Duesberg is unable to publish in prestigious peer-reviewed journals, not even the *Proceedings of the U.S. National Academy of Science*, despite his stature as a member of the National Academy, because they rewrote the rules especially to prevent him from publishing. He lost his annual \$300,000 Special Investigator Grant from the U.S. National Institutes of Health, which was expressly for the purpose of asking novel questions, and, as a result, his students and technicians have had to leave. Duesberg has been excommunicated from the scientific community. Needless to say, the review panel who refused to renew his grant included scientists who earn their living from

The usual peer review process in science provides an adequate forum for evaluating new ideas and discoveries, but this is only true if those ideas and discoveries do not challenge the paradigm.

the theories that Duesberg is undermining, and many others in the mainstream also earn their living from these theories.

Strategies Toward Progress in the Frontier Sciences

With all those obstacles and resistances, how can we help to facilitate rational, objective criticism and fair peer review of anomalous claims? What strategies can we implement to bring progress to a frontier science area such as homoeopathy and low dose bio-effects?

- We must recognize that there is no single critical experiment that can prove an anomaly. This is ridiculous from the scientific viewpoint, as the history and philosophy of science has shown that there is no such thing as a critical experiment.
- More empirical studies need to be undertaken by more researchers, and we need to work together at least to provide peer review of each others' work, if not outright collaboration. All too often, the work of pioneering frontier scientists represents isolated, individual efforts. By contrast, most quality science involves collaborative efforts. It is important to build on one another's work. Just as cooperative or collective phenomena in nature have unusual stability, there is also a strength in collective scientific efforts that is harder to dismiss.
- An interdisciplinary approach to anomalies is absolutely necessary, because we do not know ultimately where an anomaly will fit. In the case of homoeopathy or high dilution bio-effects, interdisciplinary group collaboration with experiments performed in tandem on the same high dilution would be worthwhile, because for the first time it would reveal physical, chemical, and biological information about a single preparation. This could develop into an international task force, a global cooperation, to address the problem.
- We must produce well-designed experiments that are well-communicated in the scientific literature, which will presumably continue to demonstrate the effect in a wide variety of biological systems.
- We must show replication of phenomena, especially by skeptics.
- We must also discover and document where no such anomalous effects are observed, so that the boundary conditions of the effect are clear.

- Conceptual work toward achieving a theoretical explanation for the effect is crucial for its recognition.
- We must keep communication flowing between those working in the field who don't agree on the details. A diversity of opinions is extremely important because it drives the formation of new questions. Good science requires good and effective criticism. Furthermore, failures in communication from splinter groups in frontier areas of science only weaken the case, as their presence makes a statement to the scientific community that there is weakness or irrational behavior associated with the anomaly.
- One of our best strategies would be to serve as mentors and inspire younger scientists to conduct research in novel areas of science. For one, it is most likely that presently established scientists will have to retire before a paradigm shift is completed, and most of them will not change their viewpoint. As physicist Max Planck sadly noted, "... A new scientific theory does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."¹⁹ Niels Bohr put it somewhat differently: "Science advances—funeral by funeral."
- Retired scientists, who have less to lose in terms of their reputation or funding, are occasionally more open to new ideas or discoveries. Moreover, they may still wield political power in the scientific community. Therefore, communications with or other involvement of retired colleagues may be a viable strategy.
- Another strategy that may be used to advance scientific recognition of a challenging anomaly is to identify and align with social, political, or economic interests that would very much like this particular piece of scientific unorthodoxy to be true, or at least to be highly interested in resolving the issue. When Robert O. Becker, medical researcher in bio-electromagnetics, had the unorthodox idea in the 1970s that electromagnetic fields from power lines might be a health risk, he found no sympathetic ears in the scientific community or the electric power industry. However, he communicated the issue clearly in his popular writings and launched a public campaign in which the people demanded unbiased research to test his ideas. Within less than two decades, substantial U.S. government funds became available for this purpose.
- Another approach related to this strategy is to develop a successful application of the anomaly that will bypass the scientific community altogether. Once the application is adopted, scientists will be naturally drawn to the fundamental discovery underlying it.
- Finally, we should attempt to foster true skepticism—neither denial nor disbelief, but a balanced state of openness. The best way to do this is by personal example, by maintaining a level of healthy skepticism ourselves, with an emphasis on further questions. This is crucial to keeping science an open system of inquiry.

Role of Homoeopathy and

Low Dose Bio-Effects in the Future of Science

The observations of low dose biological effects challenge the dominant paradigm of mechanical reductionism, of viewing life as a collection of biomolecules responding to molecular stimuli. The enhanced potency of very low doses, as in homoeopathy, appears to challenge molecular theory, one of the pillars of modern chemistry. On the other hand, it may demonstrate that something else is occurring at these very low doses that does not involve molecules. Biological effects of low doses have been demonstrated in a growing number of studies worldwide, and we are now in the midst of a paradigm struggle. As Kuhn predicts, an intellectual and emotional battle is occurring; there have

been nasty editorials, tenure battles, debates and arguments, splinter groups, the rejection of papers, frequent denial on the part of the scientific community, and many questions that have been raised for further research. From an historical perspective, the accretion of anomalies or numbers of anomalous observations in themselves are not enough to product a paradigm shift. Further effort is required. Conceptual work toward new theories and a paradigm that would reconcile them is critical to their recognition by the scientific community. No one other than the proponents of the anomalies will accomplish this. It remains for us, the frontier scientists, to design the theories, elaborate the new paradigm, and show how they explain our anomalies.

One of the best examples of a conceptual revolution is found in a 19th-century science fiction classic, E.A. Abbott's *Flatland*.²⁰ The inhabitants of Flatland live on a two-dimensional surface and have no concept of our third dimension. When a sphere visits Flatland, he is perceived as an anomaly: a circle that first grows bigger and then smaller. The sphere then lifts the leader of Flatland into the third dimension where he can see his whole world. This novel perspective not only clears up the anomaly, but offers a new perspective for everything. We need a similar major conceptual breakthrough for homoeopathy and low dose bio-effects. When it occurs, it may reframe our ideas of matter, energy, life, and information in a radically new perspective.

Presently the greatest challenge to those working on homoeopathy or low dose bio-effects is to develop a proper theoretical context for their observations. We need a theory of very high dilutions in the context of the organism. This would enable us to form testable questions that move the research from an accumulation of anomalous observations to a sequence of facts that fit together like pieces of a puzzle. It is becoming more apparent that molecular theory offers nothing but conceptual limitations for this field of inquiry, and that an alternative that goes beyond it must be sought. Moreover, I anticipate that a breakthrough toward a radically new view of chemistry is in the making, and it is long overdue. Quantum chemist H. Primas, wrote:

The richness of chemical phenomena renders it impossible to discuss them exhaustively from a single point of view. The molecular view is just one of these views and has no privileged status. . . While the molecular theory fell on fertile ground, the further development of a theory of chemical substances was deprived of intellectual incentive. Even today, chemical thermodynamics and chemical kinetics are still in a rudimentary state of development achieved at the turn of the century. . . The molecular idea flourished and degenerated into a dogma, requiring unqualified faith.²¹

He also wrote, "Our vision of the world will be severely limited if we restrict ourselves to the molecular view. Molecular theories describe some aspects of matter, but it is not wise to think that they give us a description of reality 'as it is.' If questions of a different kind can be asked, nature will then respond in a new language."

As to the future of science, research on homoeopathy and other low dose bio-effects offers the gift of new questions to the great scientific community—not only for homoeopathy and solution chemistry, but for the entire theory of condensed matter with ramifications for biology, chemistry, and physics. Chipping away at the molecular dogma and raising uncertainty about what scientists thought was bedrock truth should be seen as healthy for science. As physicist Louis de Broglie warned us, "The advances of science have always been frustrated by the tyrannical influences of certain preconceived notions that were turned into unassailable dogmas, and for that reason scientists must periodically re-examine their basic principles." Research

on homoeopathy and low dose bio-effects may lead to a revision or a refinement of molecular theory, or it may show that something other than molecular theory is involved at these low doses.

There is theoretical work in physics toward a new theory of matter that may hold promise for application to homoeopathy and low dose bio-effects. Del Giudice²² and Preparata²³ propose a novel theory of condensed matter based on quantum electrodynamics in which collective or cooperative phenomena are critical to its structure and properties. They show that conventional molecular theory works well for gases, but falls short in explaining the phenomena of liquids and solids. A system of molecules kept together by purely static forces becomes dynamically unstable beyond a certain density threshold. Therefore the system enters a lower energy configuration where molecules oscillate in tune with a self-produced coherent electromagnetic field. The energy gain is proportional to the particle density, and then matter is forced to condense. The theory pre-

Where there are anomalies and frontier areas of science that seriously challenge the paradigm, the scientific community is often polarized into two categories: believers and disbelievers.

dicts the appearance of coherence domains in solids and liquids such as water. Because the living cell and its structural subcomponents have dimensions of the same order of size of the calculated coherence domains in liquid water, it is expected that electrodynamic coherence may be relevant to the living state, in terms of enhanced stability and novel energy and information transactions. Such novel energy and information transactions, if they exist, may be relevant to homoeopathy.

The results of many low dose experiments suggest new features of matter such as information that may be conveyed by more subtle properties of matter than molecules. It comes as no surprise that living systems, which are well known to involve many levels of order and different types of informational exchange, appear to be sensitive to what may be "informational" properties of very high dilutions of bioactive substances. Experiments from another frontier area of biology suggest that there may be subtle non-chemical bio-informational transfer in cellular systems.^{24,25} Still other experiments suggest that the zero point energy of the quantum vacuum may be involved in subtle informational transfer in biology.²⁶ Perhaps an appropriate explanation for low dose bio-effects awaits us in a biophysics that is yet to be invented.

Whereas conventional science maintains that biological information is stored and transferred via biomolecular structures such as DNA, there is some indication that more subtle informational signals may elicit biological effects. In bio-electromagnetics there are many observations that extremely low-level, non-ionizing electromagnetic fields whose energy content is below the physical thermal noise limit can produce biological effects sometimes robust. There is no agreed molecular mechanism for these effects. It has been postulated by some that they may act on the organism in such a way that they affect the organism's endogenous electromagnetic field, which may be bio-regulatory. That is, they act at the level of the whole organism to provide bio-information or disrupt it rather than at the level of energy or power intensity directed to molecular receptors. Furthermore, it is possible that several other phenomena that elicit biological effects, such as very high dilutions,

homoeopathy, healer treatments, acupuncture, and other types of "energy medicine," may mediate their effects by means of coherent excitations, forms of electromagnetic bio-information that might interact primarily with the organism's endogenous fields. Endogenous electromagnetic fields, which are properties of the entire organism rather than of specific biomolecules, may be involved in self-regulation of the whole organism, and sensitive to a variety of subtle informational signals from the environment. These speculations not only challenge the concept of molecular mechanisms, but also the dogma that mechanical reductionism is the fundamental principle underlying the living state. However, much work needs to be done to develop these speculations into testable hypotheses and theories.

There are a number of other attacks on the mechanistic view of life which those working on homoeopathy or low dose bio-effects should be aware of. Richard Strohman, a leading molecular biologist and Professor Emeritus at the University of California, has recently presented some serious challenges to the genetic paradigm. He argues that the information for cellular activity is not in the individual genes, but is holistically located.²⁷ In his view, biological research is presently lacking this integral program. The creativity of the organism, which is perhaps life's most salient feature, involves the interplay of the integral design and function of the organism with its environment. Strohman raises the argument for an epigenetic rather than a genetic view of life, whereby environmental interactions produce heritable changes. This means that interaction between the organism and its environment is nonlinear, with the temporal sequence of events determining the complexity that unfolds even in the simplest organism. Of course, it is much easier to ask questions within the mechanistic reductionist framework by studying the fragments of a dead organism. It is much more difficult to study the interaction of genetic and environmental factors in a living organism and develop a science of life at this level. However, most biologists fail to see the limitations of their paradigm and the importance of aiming for this larger context.

There is a popular anecdote based on a Sufi story of a drunk who lost his keys somewhere in a dark street and was groping for them only under the street lamp. Asked where he lost them, he replied that he didn't know, but he was looking there because the light was good. Similarly, the dominant paradigm of mechanical reductionism has prevailed because the biology community has asked only the questions where the "light is good," and the results are clear-cut and reproducible. Biologists explore, for the most part, those dynamic possibilities for life only where organisms "obey" the paradigm.

They have missed the enormous creative potential of life in its subtle interactions and interrelationships. Furthermore, the genetic approach has not permitted "other" questions to be addressed, which, in fact, challenge the conventional approach and the dominant paradigm. Moreover, there is a terrible confusion in contemporary biology between the ontology of life, its epistemology, and the methodology. That is, the methodology used (mechanical reductionism) has frequently been equated with life itself or the model of how it functions. This is particularly true in the U.S. where higher education in science does not typically include course work in the history or philosophy of science. The whole organism may be a biological fundamental that cannot be reduced to its parts, the whole may be self-governing by virtue of its long-range electromagnetic fields that are the summation of many electrically charged component species and their interactions. This is reminiscent of the words of Claude Bernard, "The vital force directs phenomena that it does not produce; the physical agents produce phenomena that they do not direct."²⁸ In 1839, when Bernard wrote this statement, the "vital

force" was taken to mean a metaphysical concept beyond the scope of science. However, the "vital force" may indeed be a property of the whole organism, a time-varying electromagnetic field summation of all the electrically charged molecular events occurring within it. Subtle biological effects may be mediated through this subtle informational network at the level of the whole.

Conclusions

The dominant paradigm of mechanical reductionism that shaped science for the past few centuries, but was overthrown by developments in modern physics earlier this century, still governs modern biology and medicine. Mechanical reductionism, which was developed for the inanimate physical world, determines the scope of questions that can be posed for living organisms, and conventional biology is the collection of theory and results based on those questions. However, frontier scientists are exploring other features of life by asking new questions that go beyond the dominant paradigm. Their questions come from various frontier areas of science and medicine such as epigenetic heredity, bioelectromagnetics, homoeopathy, and low dose bio-effects. The results of their investigations, which may be regarded as individual anomalies by the mainstream, may be taken together as evidence for the need of a bigger paradigm to accommodate them. Biology, it appears, may be entering a crisis. Not only do these "anomalies" challenge our present view of life, but collectively they point to the necessity for a holistic view of life to complement the reductionist view. Whereas conventional science maintains that biological information is stored and transferred via biomolecular structures such as DNA, the anomalies show that other informational signals *not* stored in chemical structures may elicit biological effects by possibly altering the subtle informational signals involved in biological regulation of the whole organism.

Major changes in science have never been brought about by isolated experimental findings, but by collective evidence. Thus, it is crucial for scientists who dare to venture into tributaries of the mainstream or into uncharted terrain to come together to enter into dialogue and share their data, to find that what may seem as isolated anomalies fit together to form the rudiments of an emerging paradigm. It is important to look at the problems of our science and the gaps in our knowledge. We must continually ask new questions and never be satisfied with the old ones, nor with the answers that have come to pass. Scientists must continually be motivated by the "mother" of all questions: what facets of nature remain undiscovered because what we consider to be theoretical certainties prevent the posing of new challenging questions?

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Device Testing continued from page 16

es the credibility of the report in my eyes, as I would expect a simple artifact to occur every time, since the output helium rises in a simple, untroubled line. My meager wits are unable to imagine any applicable artifact. Therefore, I expect this breakthrough success to continue at SRI, and to be speedily replicated by other labs. In addition, since in physics, the basic rule is that what is not prohibited is mandatory, then we must give much greater credence to the vast body of reports of the many varieties of cold fusion in the last ten years. The seedling has not expired and deserves copious watering. Without being specific, McKubre said that theoretical progress was being made."

True to the "hint and run" behavior of skeptics, Murray later backed-away from his positive assessment and came up with an easily dismissed objection: that covertly bound helium might have been emitted by the catalyst itself! There is no credible evidence that this could be occurring, especially in view of the fact that no helium was found to build up in the ordinary hydrogen or deuterium control test with the same batch of catalyst. It is quite clear now that this catalytic fusion direction is among the most promising of the low energy nuclear reaction processes.

Calorimeter Development:

NERL's flow calorimeter went through a redesign when the previous design, which employed pulse width modulation, failed to meet stringent inlet water temperature requirements. A better method using amplitude modulation resulted in vastly improved regulation, which will enable better calorimeter sensitivity. Further testing and some tuning will soon enable us to perform this versatile form of calorimetry. □ □ □

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About the Author

Beverly Rubik, Ph.D., biophysicist, is a leading scientist exploring the frontiers of science, medicine, and spirit. In 1996, Dr. Rubik founded a non-profit institute, the Institute for Frontier Science in Oakland, California for research and education on subtle energies, consciousness, and energy

medicine. She is author of *Life at the Edge of Science* and *The Interrelationship Between Mind and Matter*. She serves on the editorial board of five medical journals, including *Alternative Therapies in Health and Medicine*. She is a member of the Program Advisory Council at the NIH National Center for Complementary and Alternative Medicine. She is also an adjunct faculty member at several universities and a consultant.

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6114 LaSalle Avenue, Oakland, CA 94611

Editorial continued from page 5

U.S. patent process and influence journalistic accounts). How this Miley award slipped through the normally vicious opposition within DOE is difficult to discern. It is a wonder, that's for sure! When we learn more about how this happened, we'll let our readers know.

Some people say that on these pages we should be kind to the DOE, because of this landmark award to Miley and other initiatives that may be afoot. Hell no! We say to the DOE—"What took you so long?" Whom do you claim to represent: special academic interests or the people of the United States? Deputy Secretary of Energy Dr. Ernest Moniz—former head of the MIT Physics Department—are you listening? We hope you are. Are you listening to some of your underlings who know that the DOE's war against cold fusion should come to an end—now?

Is U.S. Energy Secretary Bill Richardson listening? Not to our knowledge, even though we are told he had some time to reflect on the message of *Infinite Energy*, Issue No. 24, the 10th Anniversary of Cold Fusion issue. His latest project is to push for the U.S. to generate 5% of its electricity by windmills in the year 2020. More power to him for that, but what about a little wind from him about cold fusion?

The Miley contract and his study's nearly certain success, based on his past work, establishes a gaping crack in the foundation of DOE's opposition to cold fusion. Politicians who hold the purse strings for DOE may take note and wonder whether it is time to force DOE to make a long overdue re-evaluation of cold fusion—this time based on a decade of clear experimental evidence in support of the phenomenon.

In other news: the venue for the Eighth International Conference on Cold Fusion has been set: Frascati, Italy, May 21-26, 2000—the first international cold fusion conference of the new millennium. Sponsorship is by the Italian National Institute of Nuclear Physics and the Italian Physical Society. Italy, following in the more modest footsteps of France, is beginning to set up the infrastructure of a national cold fusion program.

With all the forgoing, are we witnessing a dimly glimpsed "light at the end of the tunnel" in the prolonged struggle against forces of darkness, or is this an illusion as some past optimistic tidings turned out to be? Could the light be from that metaphoric train bearing down on weary, bleary-eyed seekers? Is this an auspicious light of day at the end of the interminable "tunnel," or does the apparent glow come from a dangerous "train"? Let us hope it is the former as we forge ahead. ∞



COMPILED BY EUGENE MALLOVE



ICCF-8 Site and Dates Set Announcement Received from Italy The 8th International Conference on Cold Fusion

Villa Marigola, Lerici (La Spezia), Italy
May 21-26, 2000

The "8th International Conference on Cold Fusion," ICCF-8, will take place in Lerici, Italy, during the week of May 21-26, 2000. The study of Cold Fusion (CF) phenomena, sometimes referred to as "New Hydrogen Energy" (NHE), is progressing in numerous laboratories all around the world. More than ten years old, the field is enjoying ever more reproducible experiments and better interactions with the scientific community. A large variety of experimental approaches will be addressed in the Conference, together with theoretical attempts to interpret the observed phenomena. The important sponsorships that have been secured for ICCF-8 guarantee that the Conference will maintain the most rigorous scientific standards.

List of Topics

- Heat and related products
- Nuclear processes and transmutations
- Materials
- Innovative approaches
- Theories

Conference Policy and Organization

The Conference will consist of oral and poster presentations. The official language of the Conference will be English. Pre-registration, registration, and submission of abstracts should preferably be performed using the Conference Web-page, which will be updated, and will provide all necessary information and interactive procedures. Those who have difficulties using an internet connection are kindly requested to contact the Secretary of the Conference.

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The Italian *Consiglio Nazionale delle Ricerche* (CNR), the Italian *Istituto Nazionale di Fisica Nucleare* (National Institute of Nuclear Physics), and the *Società Italiana di Fisica* (Italian Physical Society)



Japan Cold Fusion Research Society Established

The Japan Cold Fusion Research Society, JCF (Japan CF-Research Society), was established March 29, 1999 at the First Annual Meeting of the JCF, which was held in Osaka. On March 29 and 30, twenty papers were presented, including three theoretical ones. There were about forty attendees. Papers were presented by Y. Arata, Y. Iwamura, H. Kozima, T. Mizuno, R. Notoya, T. Ohmori, K. Ota, A. Takahashi, N. Yabuuchi, H. Yamada, E. Yamaguchi, and others.

The following are representatives of JCF: Senior Consultant Members: Yoshiaki Arata, Michio Enyo, Hideo Ikegami, and Hideo Kozima.

Director-in-Chief, Akito Takahashi.

Deputy Director-in-Chief, Kennichiro Ota.

Directors: Naoto Asami, Yoshiyuki Asao-ka, Yasuhiro Iwamura, Hideo Kozima, Tadahiko Mizuno, Kennichiro Ota, Akito Takahashi, Eiichi Yamaguchi, Hiroshi Yamada.

Meetings will be held annually, the next one to be held in Hokkaido in 2000. The Society maintains a web site at: <http://fomcane.nucl.eng.osaka-u.ac.jp/user/jcf/>

The e-mail address of Prof. Akito Takahashi is as follows:

akito@nucl.eng.osaka-u.ac.jp

The above report is based on e-mail from Dr. Hideo Kozima, Professor Emeritus at Shizuoka University, Senior Consultant Member and Director of JCF. Cold Fusion Research Laboratory, Yatsu 597-16, Shizuoka 421-1202, Japan; e-mail: cf-lab.kozima@nifty.ne.jp Tel/Fax +81-54-278-0327

Received from Director-in-Chief: Prof. Akito Takahashi.

Statement of Purpose in Founding the Japan CF-Research Society (draft)

This society shall be called, in Japanese, "the CF research society" and in English "the Japan CF-research society," abbreviated JCF. CF stands for Condensed-matter (solid state) Fusion, Coherently-induced Fusion, or Cold Fusion. All the terms refer to a nuclear reaction inside a solid state body. The term CF is also meant in the broader sense to include the science and technology associated with the phenomenon. The main goal of the society is to investigate the nuclear reactions that occur in the solid-state, and ultimately to develop techniques to extract energy from these reactions.

We do not think it is necessary for us to reiterate the reasons why associations of this type play such an important role in promoting sound development in science and technology. We have long felt concerned that cold fusion, like any other area of science, needs an organization to collect data about and promote general interest in the field. Despite this pressing need, however, nothing like the CF Research Society has been formed until now for two main reasons: First, because the existence of the so-called cold fusion reaction has not been widely recognized, and very few scientists and researchers concentrate on it as their main occupation. Second, because cold fusion research requires an interdisciplinary, multi-disciplinary approach involving scientists for many different fields, who would not normally meet together or form a society.

In recent years, a great deal of experimental data has indicated that new phenomena exist, which originate in condensed (solid-state) matter when various physical and chemical conditions are satisfied, giving rise to, for example, coherently-induced nuclear fusion. This process is intrinsically different from the nuclear reactions discovered heretofore,

which are random rather than coherent processes. CF has characteristics peculiar to the solid-state environment. It has given rise to an effusion of new discoveries in physics, chemistry, material science, and nuclear engineering. Cold fusion research crosses traditional academic domains and requires an interdisciplinary approach, so we hope that researchers from many fields will join us in these efforts. We hope that opening up the field will be the most significant outcome of the establishment of this CF Research Society. Another significant goal of the Society is to enhance Japan's role as a focal point of research in this area, and to act as a clearing house for international cooperation and information exchange.

The CF society is an unofficial organization, without legal standing.

Titles from the first meeting of the Japan CF Society (JCF-1):

JCF 1-1, Heat, radiation measurements and detection of reaction products induced by the glow discharge in electrolyte. *T. Mizuno, T. Akimoto, T. Ohmori (Hokkaido University)*

JCF 1-2, Intense excess heat production observed during glow discharge with tungsten/light water electrolysis. *T. Ohmori (Hokkaido University)*

JCF 1-3, "Excess heat" at the beginning of electrolysis in K_2CO_3 light water solution. *T. Okabe, N. Motohira, N. Kaniya and K. Ota (Yokohama National University)*

JCF 1-4, Observation of thermal neutron capture by proton. *R. Notoya (Catalysis Research Center, Hokkaido University)*

JCF 1-5, Observation of solid-state nuclear reactions induced by the multi-layer cathode with low work function material. *Y. Iwanura, T. Itoh, M. Sakano, N. Gotoh (Mitsubishi Heavy Industries)*

JCF 1-6, Mass analysis experiment after electrolysis using Pd-cathode with metal film. *K. Yabuta, S. Ueda, A. Takahashi (Osaka University)*

JCF 1-7, Solid-state nuclear reactions induced by continuous diffusion of deuterium gas through Pd. *M. Sakano, T. Itoh, Y. Iwanura, N. Gotoh (Mitsubishi Heavy Industries)*

JCF 1-8, Study of fusion in solid by using D_2O electrolysis method, a nuclear reaction analysis. *Y. Isobe, Y. Kawamishi, A. Takahashi (Osaka University)*

JCF 1-9, Characteristics of DS-cell. *Y. Arata, Y.C. Zhang (Osaka University)*

JCF 1-10, Production of radioactive element in deuterated Pd induced by glow discharge and decompression. *H. Yamada, N. Kawata, M. Nakai, K. Iwasaki, Y. Kurisawa, X. Li (Iwate University, engineering department)*

JCF 1-11, Analyses of the excess heat generated from Pd:D/Au heterostructures by the "in-vacuo" method. *E. Yamaguchi, H. Sugiura (IMRA Europe)*

JCF 1-12, X-ray spectrometric analysis of carbon arc products in water and alkali carbonates solution. *T. Hanawa (Osaka University)*

JCF 1-13, Studies of nuclear reactions in solid in titanium deuteride under ion beam implan-

tation—experiments with deuteron beam implantation. *O. Kentaro, O. Takayuki, M. Hiroyuki, T. Akito (Osaka University) W. Teishan (Chinese Institute of Modern Physics)*

JCF 1-14, Studies of nuclear reactions in solid in titanium deuteride under ion beam implantation—experiments with hydrogen beam implantation. *O. Takayuki, O. Kentaro, M. Hiroyuki, T. Akito (Osaka University) W. Teishan (Chinese Institute of Modern Physics)*

JCF 1-15, Energy spectrum of particles emitted from deuteron irradiated thin-TiD_x film. *K. Naoyoshi, T. Masakatu, N. Masataka, F. Hiroki, T. Akira, K. Akira (Kobe University of Mercantile Marine)*

JCF 1-16, Simulation of transient coherent motion for hydrogen isotope in metal—electron state and mechanism of transient coherent motion. *O. Masayuki, T. Akito (Osaka University)*

JCF 1-17, Low temperature elastic anomalies and heat generation of deuterated palladium. *M. Fukuhara (Toshiba Tungaloy), H. Numata (Tokyo Institute of Technology)*

JCF 1-18, Possible dynamic interaction of deuteron between Tetragonal and Octahedral Interstices of Pd lattice at cryogenic temperatures. *M. Fukuhara (Toshiba Tungaloy)*

JCF 1-19, Neutron energy band and cold fusion phenomenon. *K. Hideo (Shizuoka University, Engineering Department and CF Research Laboratory CFRL)*

JCF 1-20, Two kinds of theories of cold fusion within solids. *N. Yabuuchi*

JCF 1-21, Neutron energy band and cold fusion phenomenon. *K. Hideo (Shizuoka University, Engineering Department and CF Research Laboratory CFRL)*

JCF 1-22, Two kinds of theories of cold fusion within solids. *N. Yabuuchi*



Professor George H. Miley of the University of Illinois Awarded a DOE Contract for Low Energy Nuclear Reactions (LENR) Study

The first Overt DOE cold fusion funding since 1989!

In a stunning milestone in cold fusion history, Prof. George H. Miley of the Department of Nuclear Engineering at the University of Illinois has been awarded a contract to conduct a "Scientific Feasibility Study of Low-Energy Nuclear Reactions (LENRs) for Nuclear Waste Amelioration."

The Miley proposal (#99-0222) was selected by the DOE's Nuclear Energy Research Initiative (NERI) program as one of forty-five awards made on May 7, 1999 that "resulted from the independent peer-review" of 308 proposals received by the DOE from universities, national laboratories, and industry. Nineteen million dollars was appropriated for the NERI Program in FY 1999. Forty-six separate organizations are involved in the FY 1999 NERI awards, including twenty-one universities, eight national laboratories, sixteen industrial organizations, and one Federal Government research organization. Many of these projects are collabora-

tive research efforts among multiple organizations. The awards also involve substantial foreign collaboration with four universities and six industrial/R&D organizations, including organizations in France, Japan, Italy, Great Britain, and Canada.

Miley's award stands out because it is based on remarkable new physics from the cold fusion field. The historic abstract of Miley's award is reproduced here in full:

U.S. DEPARTMENT OF ENERGY NUCLEAR ENERGY RESEARCH INITIATIVE ABSTRACT

PI (Principal Investigator): George H. Miley
Proposal No.: 99-0222

Collaborators: None

Institution: University of Illinois

Title: Scientific Feasibility Study of Low-Energy Nuclear Reactions (LENRs) for Nuclear Waste Amelioration

This project falls under the NEER topic of "New Technologies for Management of Nuclear Waste." Recent research at the University of Illinois and elsewhere suggests that nuclear transmutation reactions can occur when thin metallic films are highly loaded with protons (>0.9 protons per metal atom) and other auxiliary conditions, e.g. low electric fields, are used to trigger the reaction. This discovery seems certain in view of the growing reports of such phenomena, but further confirmatory scientific-feasibility experiments seem prudent before launching a major effort based on this breakthrough science. That is the purpose of the one-year project proposed here. If successful, an enlarged multi-lab follow-on project to scale up to pilot-plant levels would be proposed.

Basic transmutation studies at the University of Illinois have successfully used nickel, palladium, and titanium for the film, the most concentrated reactions occurring with multi layers of thin films consisting of layers of alternating metals, e.g. Pd/Ni. The loading was conveniently done with an electrolytic cell, although other techniques, such as high pressure gas loading or accelerator bombardment loading, could be employed. Evidence that this phenomenon has a nuclear origin is two-fold. An excess energy is released during the experiment which continues over three to four-week runs, and the integrated output energy far exceeds that possible with a chemical source. Also, a wide variety of new isotopes that could only come from nuclear reactions have been observed based on detailed analysis of the composition of the films following runs.

Based on the encouraging results from these basic thin-film experiments, runs

were made with natural uranium and also thorium-impregnated carbon electrodes. These studies were intended to investigate possible transmutation of radioactive waste to less radioactive isotopes. In this case many of the expected transmutation reaction products appeared, but the thick electrodes employed reduced the product analysis accuracy, leaving the results encouraging but uncertain. The project proposed now is to carry out an intense one year study that conclusively demonstrates this transmutation concept using thin-film uranium/thorium electrodes with a significantly larger cell volume (50 cc vs. the 0.5 cc in present experiments) than employed in the earlier thin-film experiments. With uranium, and the larger volume and the improved control offered by the thin films, the product analysis would be significantly above background, clarifying the feasibility of this approach to nuclear waste amelioration. Concurrently with the experiments, computer simulations of lattice dynamics under high loading are proposed to add understanding and guidance for the experiments. If this combined experimental simulation study is successful, an expanded project would be proposed in the next FY to construct a pilot-plant size unit to study the engineering feasibility of the approach. This new field of low-energy nuclear reactions (LENRs) is so fundamental that it is impossible to predict where it will lead. Nuclear waste amelioration is one of the more obvious possibilities. Small nuclear power cells may also be feasible. Beyond scientific feasibility, all such applications must stand the tests of engineering and economic feasibility. In any case, the new fundamental knowledge gained from the proposed project could start a movement towards a whole new field of nuclear reaction applications, in addition to waste management. (End of Abstract)

The Miley work funded by DOE comes under the Nuclear Energy Research Initiative, an overview of which is given at NERI's website [<http://neri.ne.doe.gov>]:

"The Department of Energy (DOE) created the Nuclear Energy Research Initiative (NERI) to address and help overcome the principal technical and scientific obstacles to the future use of nuclear energy in the United States. NERI is also expected to help preserve the nuclear science and engineering infrastructure within our Nation's universities, laboratories, and industry, to advance the state of nuclear energy technology and to

maintain a competitive position worldwide. DOE believes that in funding creative research ideas at the Nation's science and technology institutions and companies, solutions to important nuclear issues will be realized, and a new potential for nuclear energy in the United States will emerge."

Background on how this program began is provided in a key paragraph:

"In January 1997, the President tasked his Committee of Advisors on Science and Technology (PCAST) to evaluate the current national energy research and development (R&D) portfolio and to provide a strategy that ensures the United States has a program to address the Nation's energy and environmental needs for the next century. In its November 1997 report responding to this request, the PCAST Energy Research and Development Panel determined that restoring a viable nuclear energy option to help meet our future energy needs is important and that a properly focused R&D effort should be implemented by DOE to address the principal obstacles to achieving this option. These obstacles include issues involving proliferation, economics, nuclear waste, and safety. The panel recommended that technologies to be addressed include, but not be limited to, work on proliferation-resistant reactors or fuel cycles; new reactor designs with higher efficiency, reduced cost, and enhanced safety to compete in the global market; lower output power reactors for applications where larger reactors may not be advantageous; and new techniques for on-site and surface storage and for permanent disposal of nuclear waste."

More on the awards comes from a section titled "New R&D Approach":

"DOE is making a fundamental change in the management of its nuclear energy research activities. DOE's new approach with NERI features a competitive, peer-reviewed, R&D selection process to fund researcher initiated R&D proposals from the universities, national laboratories, and industry. NERI will be managed by DOE's Office of Nuclear Energy, Science and Technology and will receive guidance from the Nuclear Energy Research Advisory Committee (NERAC). NERAC's primary function will be to assist DOE in effectively carrying out its role in nuclear energy research. The advisory committee consists of expert members from a wide variety of research backgrounds and perspectives."



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—Arthur Schopenhauer, 1788–1860

Submitted to *Infinite Energy* by Mark Goldes, CEO, MPI/ROOTS

Cartoon below sent in by Bert Maupin, subscriber.
Reprinted with permission of Chad Carpenter.



"The Dead Scientists Poetry Society"

"I'D MUCH RATHER HAVE BREWED CIDER"
by Isaac Newton

BY
SUSAN
SEDDON

I made a lousy farmer
Of that there's little doubt.
So they packed me off to Cambridge
It took the Plague to get me out.

I was supposed to join the Church
But I studied math instead.
That wasn't quite intentional
I blame that blow on the head.

It made me dream of orchards
That ballistic Red Delicious.
So I invented calculus
To make tree-planting more propitious.

I fancied growing Cox's
Juicy Braeburns. . .Granny Smiths.
That an apple led to Principia
Is one of my favorite myths.

As for defining gravity
Sometimes I want to cuss it.
I'd rather admire the blooms upon
My Gold Medal-winning Russett.

Now picking apples, that's an art
I'd elevate to a science.
A good, long ladder's all I'd want
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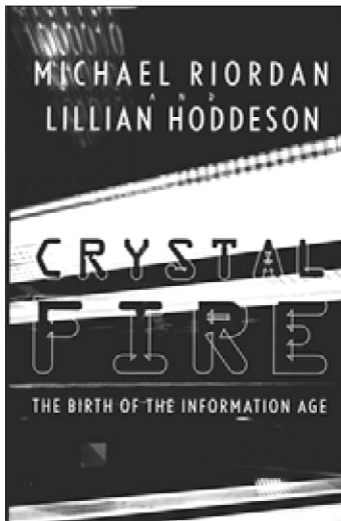
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Transistors and Cold Fusion-Part 2

Jed Rothwell



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by Michael Riordan and Lillian Hoddeson
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No Permanent Winners, No Manifest Destiny

Part 1 (see *Infinite Energy* No. 25, p. 32-34) closed with the questions: Was the transistor truly inevitable? Where would we be without it? Is any innovation inevitable and unstoppable? I conclude that fundamental breakthroughs, like the transistor, are not inevitable, but once they are made, contingent, derivative or follow-up breakthroughs like integrated circuits become inevitable. The discovery of cold fusion was not inevitable by any means, and cold fusion technology may never be developed because of technical difficulties or political

opposition, but if it is developed and it becomes established, many contingent breakthroughs, like home power generators, will become inevitable.

The book *Crystal Fire*¹ begins with a quote from Bill Gates: "Without the invention of the transistor, I'm quite sure that the PC would not exist as we know it today." That is the conventional wisdom, and it is probably right. On the other hand, ours may not be the best of all possible worlds, and it is conceivable that something better than the transistor might have been discovered, resulting in better PCs. Furthermore, the transistor itself may not be as important as the integrated circuit, in which transistors, resistors, capacitors, and other circuits are fabricated together and miniaturized. Integrated circuits were developed in 1958, but they might have come along sooner and they might have been easier to manufacture if they had not been made with semiconducting silicon. (As explained below, integration with silicon looked like a bad idea at first.)

By the 1940s, people understood that something better than the vacuum tube amplifier was needed. Vacuum tubes were fragile, bulky, and they consumed thousands of times more power than was necessary for the job. Many people thought that a solid state device would be the best choice and different solid state devices were developed. AT&T came up with the transistor; Univac developed a solid state "magnetic amplifier," which worked better and faster in some computer applications than the transistors available in the early 1950s.² A replacement for the vacuum tube was inevitable, but it might have been . . . a better vacuum tube. Tubes might have been shrunk down to microscopic dimensions and integrated with other circuits on a chip made from some material cheaper and easier to handle than silicon. Such vacuum tubes were developed as high speed signal processors for special applications. Microscopic, mass-produced vacuum tube technology is presently undergoing a renaissance in low power, flat panel, high resolution plasma screens for televisions and computer monitors. I asked a leading researcher in this field, Charles Spindt³ of SRI, to speculate about this. He responded:

. . . sure, if solid state never came along, Ken Shoulers' and Don Geppert's ideas on integrated micron-sized "vacuum tubes"—Vacuum Microelectronics—from the late 1950s and early 1960s could be what we would be using today, but it sure wouldn't have been easy . . . and might not have happened. I expect that even if there had been a twenty year head start for microvacuum devices, solid state would have become *a* or *the* major technology eventually.

Technology is Forever in Flux

When AT&T announced the invention of the transistor, its importance was recognized immediately, but many years and millions of dollars of intense development were needed before the transistor was established as a practical replacement for vacuum tubes in most applications. Devices invented for one purpose often end up being used for other purposes. Transistors were invented to replace amplifiers, which of course they did, but they were not suited for use in computer circuitry until the mid 1950s, when IBM and others decided they were the wave of the future. AT&T announced the transistor in 1948 and distributed sample devices that same year. Many major U.S. corporations launched large scale, intense research and development projects immediately. IBM held back until 1955, when it began the "Stretch" computer project. "It was . . . obvious that an enormous investment would be required to develop the infant transistor technology." The Stretch used 169,100 transistors. The solid state devices of that time "were neither fast enough nor had they the current carrying capabilities to drive the ferrite core memories." Engineers who had been trained to work with vacuum tubes had difficulty adjusting to the new technology. "For a time the laboratory expressly forbade anyone to have a piece of vacuum tube equipment visible within his work area." In 1956, eight years after the initial breakthrough, IBM still had no transistor manufacturing facilities. It had to buy initial lots of transistors from Texas Instruments.⁴

People have a false sense that our way of life is permanent and our tools have been with us for a long time. We think of computer random access memory (RAM) as the main use of transistors, but until 1970 most RAM was made of ferrite core. Transistors remained difficult to manufacture and expensive. In 1966, after eighteen years of massive, worldwide research and development, semiconductor computer RAM memory cost roughly \$1 per bit compared to \$0.10 for magnetic core or film, or \$0.01 for slow ferrite core.⁵ Ferrite core memory is used in the Space Shuttle, which was designed from 1972 to 1978. RAM was also made of thin films, plated wire, and in early computers, rotating magnetic drums like today's hard disks. Semiconductor RAM was too expensive for primary storage. It was used for fast, CPU scratch pad memory.⁶ Magnetic ferrite core dominated for fifteen years, semiconductors replaced it for thirty years, and if recent developments pan out, magnetic memory may soon make a comeback, replacing semiconductors again. Magnetic RAM remains attractive because it is fast and it holds data without consuming power even when the computer is turned off.⁷ New kinds of memory may replace semiconductors. Exotic, three-dimensional, holographic RAM might be perfected. A holographic memory chip the size of a sugar cube would hold terabytes (a million times more than today's RAM)

and it would operate thousands of times faster.⁸ In hand held computers and digital cameras, tiny fast hard disks may soon replace semiconductor memory, a revival of the magnetic drum. Since 1986, the cost and data density of hard disks have been improving faster than semiconductors, confounding industry predictions.⁹

Competing solutions to the same problem—like magnetic versus semiconductor RAM—often race neck and neck for years. Sometimes they end up converging, when someone finds a way to combine the best features of both. A good example is the competition between propellers and jet engines. The Wright brothers invented the pusher propellor mounted on the back of the wings, which kept the air stirred by the propellers from affecting flight performance. This was followed by tractor propellers mounted on the front of the airframe or on the wings. The propellor works best at speeds below 400 mph, and it does not work at all above 500 mph, when the blade edges exceed the speed of sound. The “pure” jet, or turbine engine, was invented in the 1940s. It works well at or above the speed of sound, but it is inefficient at slower speeds. The turboprop engine—a jet driving a conventional propellor—came next. It has excellent flying qualities, fuel economy, and reliability, but it cannot go above the 400 mph propellor speed limit. Finally, the propellor was placed inside the engine cowl to make the fanjet, which is the biggest and most efficient engine yet. It is a hybrid, combining the advantages of propellers and jets. General Electric occasionally advertises a futuristic looking jet engine with an unducted fan at the back of an engine which is mounted on the rear of the airframe, bringing us back to the Wright brothers’ pusher propeller design.

... the commercial development of the turbine passed through some paradoxical stages before arriving at the present big jet era. Contrary to one standard illusion, modern technology does not advance with breathtaking speed along a predictable linear track. Progress goes hesitantly much of the time, sometimes encountering long fallow periods and often doubling back unpredictably upon its path.¹⁰

In the mid-1960s, people did not know that semiconductors would soon become the dominant form of RAM, and they continued to pour money into commercially successful but obsolescent alternatives like magnetic cores, thin films, and plated wire. In 1966, RCA advertised that it was developing superconducting cryoelectric computer memories which “offer far greater potential bit-packing density in computer memory elements than does any current state-of-the-art system . . . and at a far lower cost per bit.” The advertisement boasted that a 3 cm square memory plane “might well contain as many as one million bits!” This was ten times better than the best ferrite core memory plane then available.¹¹

Research and development is risky; companies lost fortunes backing the wrong kind of transistor, or the right kind at the wrong time. An engineer who worked on the 1955 Univac LARC supercomputer wrote:

The development of a 4 μ sec memory was a great technical challenge (otherwise known as a headache). The biggest problem without apparent solution was that there wasn’t a transistor available that was capable of driving heavy currents that could switch fast enough. If only the memory could have been designed two years later, the problem would have disappeared. The problem was resolved but in

a brute force, expensive manner. . . all problems were solved, but at great expense and delay to the program. LARC is an example of the price that must be paid for pushing the state of the art before it wants to be pushed.¹²

When a technology is just beginning, people do not have a sense of how the machine should look or what the best use for it will be. In the early days of automobiles, airplanes, RAM memory, and personal computers, inventors created a wonderful effusion of picturesque and improbable designs. Transistors were first made of germanium, then later silicon. Competition was hot from the start. Soon after Bell Labs invented grown junction devices, General Electric announced the alloy junction, which was easier to manufacture. RCA licensed GE’s design and soon began mass production. In a recent interview, Jack Kilby recalled:

The semiconductor technology, in general, changed very rapidly in the 1950s. We went through, I think, six completely different types of transistor structures in that period from point contact to grown junction, alloyed junction, surface barrier, diffused base, and planar. This could be done in part, because the equipment was very inexpensive. Not much money was involved in tooling so that basic changes of that type could be accomplished.¹³

Many different cold fusion devices have been developed, using palladium, nickel, and superconducting materials. Loading has been achieved with electrolysis, electromigration, deuteron beams, and various other methods. Critics say this effusion of techniques means that scientists are floundering around. They are floundering, but this is a healthy, normal part of dynamic, early stage, freeform discovery.

Integrated Circuits Looked Like a Bad Idea

After transistors became practical, other inventions were needed to make them ubiquitous. To start with, engineers could not pluck out triode vacuum tubes and install transistors instead; they had to redesign products from scratch and re-educate themselves in the process, like the IBM engineers working on the Stretch computer. Conventional heaters and motors will likewise have to be redesigned to utilize cold fusion power.

Transistor innovation did not end when AT&T was granted a patent. Transistors required a tremendous amount of research. They underwent many changes, growing faster and more powerful as new types were introduced and as fabrication equipment and materials improved. Improvements continue to the present day and will continue for as long as transistors are used. The most important innovation in transistor design was the integrated circuit, invented independently in 1958 by Robert Noyce and Jack Kilby. An integrated circuit consists of two or more transistors, resistors, capacitors, and other circuits, including the wires connecting them, fabricated together on a single piece of silicon. At first glance, integration seemed like a peculiar idea because, as Kilby explained, “Nobody would have made these components out of semiconductor material then. It didn’t make very good resistors or capacitors, and semiconductor materials were incredibly expensive.”¹⁴ It turned out to be a great idea because it reduced labor and errors and it allowed circuits to be miniaturized. Today, millions of circuits occupy the space formerly taken by one. In a sense, integration and miniaturization were more beneficial than the discovery of the transistor itself.

Integration became inevitable after a printing technique, photolithography, was successfully applied to fabricating transistors. (This is a good example of an old technology used for a

new purpose.) Robert Noyce explained that with photolithography, Fairchild produced hundreds of transistors on one piece of silicon, "But then people cut these beautifully arranged things into little pieces and had girls hunt for them with tweezers in order to put leads on them and wire them all back together again . . . Then we would sell them to our customers, who would plug all these separate packages into a printed circuit board." This was a waste of time, effort, and money. Even though silicon was expensive, it was worth making resistors and capacitors out of it to eliminate this step. Noyce concluded that integration was inevitable: "There is no doubt in my mind that if the invention hadn't arisen at Fairchild, it would have arisen elsewhere in the very near future. It was an idea whose time had come, where the technology had developed to the point where it was viable."¹⁵

Integration, like zone refining (a purification technique developed at Bell Labs; see Part 1), is not directly related to transistors, but it was developed in response to the transistor boom. Integration would have been valuable even if transistors had not come along. In fact, it might have delayed or prevented transistors if it had come first, because, as explained above, it works well with vacuum tubes, and it might have been used to make millions of tiny tubes or magnetic core memories.

Transistors Never Became Easy to Reproduce

In Part 1, I said that one of the myths spread by cold fusion opponents is that soon after things are discovered, they become easy to reproduce. Transistors never became easy to reproduce. Integrated circuits are even worse. In the 1980s, after three decades of the most intense high-tech R&D in history, more than 50% of factory die yields had to be scrapped. Today 10 to 20% fail. This is mainly because circuit density keeps increasing; if manufacturers were still producing 64 K RAM chips, the yield would be high. But it is also because of fundamental limitations in knowledge and know-how. Reproducibility problems were gradually overcome not by simplifying the problem or finding a general principle which allows "any scientist" to reproduce a transistor easily, as the skeptics seem to believe, but by a combination of heroic measures and "a plethora of small continuous improvements," as an Intel plant manager put it. Heroic measures, or brute force solutions, means building clean rooms, dressing technicians in Gore-Tex astronaut suits and goggles, and other extreme measures to exclude contamination. Intel maintains such tight control over the machinery in its clean rooms that when an equipment supplier wishes to use a different kind of screw to hold the face plate onto the equipment cabinet, the supplier must inform first Intel and go through a complex approval process. Such measures would not be needed if this were an exact science. Intel would simply spell out the specifications for screws, telling its vendors what parts to use and what parts to avoid.¹⁶

The Advantages of Open Development

A few cold fusion scientists claim they have viable heat producing cells. They are apparently sitting on these devices, trying to perfect the technology by themselves, presumably so that they will get a larger share of the scientific credit or royalties. Others, like CETI, talk about establishing a "coordinated" research program with a small number of "research partners." These strategies will not work. Cold fusion is too big to be developed by any single company, or with a planned program of coordination and cooperation. Even AT&T was not big enough to handle the transistor. When one person, one company, or the DOE is in charge of development, even if it only "coordinates" research, the decision makers will probably make a wrong turn and ruin everyone's prospects. AT&T soon went

astray in transistors, ignoring the development of integrated circuits for several years.

In 1948, soon after AT&T filed for a patent for transistors, they began shipping sample devices to leading U.S. laboratories including the Army Signal Corps, Los Alamos, the Naval Research Laboratory, General Electric, Motorola, RCA, Westinghouse, and others. In 1951, AT&T and the Joint Chiefs of Staff argued over whether the transistor should be classified. AT&T prevailed, but it agreed to abide by the recommendations of the Joint Chiefs of Staff, "to guard the special manufacturing processes so essential to the success of transistor development and production with all possible care short of actual military classification."¹⁷ AT&T wanted to reveal full details. This was partly in response to pressure from Justice Department anti-trust lawyers, but it was also because AT&T managers understood that even AT&T was not big enough to tackle transistors on its own.

In September 1951, seven busloads of the nation's top scientists and engineers were invited to a Bell Labs laboratory for a five-day symposium on transistor performance and applications. Manufacturing processes were not revealed. In April 1952, another nine-day hands-on training seminar was held for companies that had paid the patent licensing fees. This time, AT&T revealed everything. Mark Shepherd, a Texas Instruments engineer, recalled, "They worked the dickens out of us. They did a very good job; it was very open and really very helpful."¹⁸

Other companies soon began manufacturing transistors and paying AT&T royalties. Texas Instruments and others soon made better transistors than AT&T for some applications. AT&T purchased them and saved money in their telephone network. Long distance direct dial service began in 1951, just as the first transistors were being installed in the network. It led to a huge increase in long distance telephone calls and profits. AT&T might have given transistor technology to other companies for free instead of licensing it, yet it still would have benefited tremendously.

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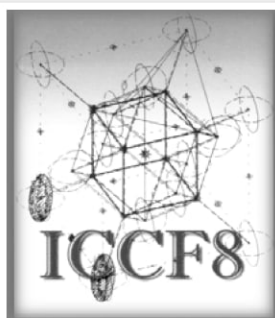
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Asti International
Workshop on Cold Fusion
October 22 - 24, 1999
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ICCF-8, Eighth International
Conference on Cold Fusion
May 21 - 26, 2000
Lerici (La Spezia, Italy)

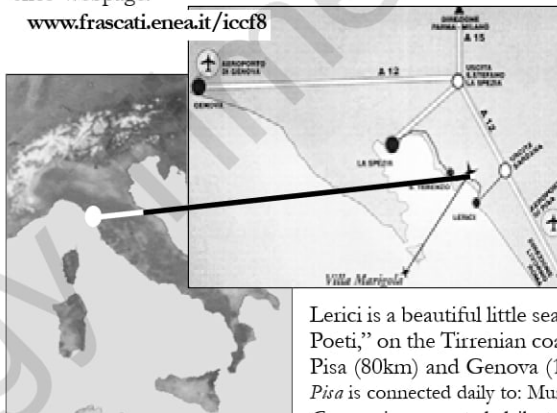
8th International Conference on Cold Fusion May 21-26, 2000



The Conference will consist of oral and poster presentations. The official language of the Conference is English.

Pre-registration, registration and submission of abstracts should preferably be performed using the Conference Webpage:

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Organized by: The Italian Agency for New Technologies, Energy and the Environment

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VILLA MARIGOLA is situated on a hill just outside the village of Lerici. Shuttle service will be available for the five days of the meeting to/from Lerici from Villa Marigola. The mild Liguurian climatic conditions are extremely suitable to activities all year long. The hotel owners guarantee that this is a place where work can be mixed with moments of peaceful relaxation and where excellent food can be enjoyed.

The 8th International Conference on Cold Fusion, ICCF-8, will take place in Lerici, Italy, May 21-26, 2000. The study of Cold Fusion phenomena, sometimes referred to as "New Hydrogen Energy," is progressing in numerous laboratories all around the world. More than ten years old, the field is enjoying ever more reproducible experiments and a better interaction with the scientific community. A large variety of experimental approaches will be addressed in the Conference together with theoretical attempts to interpret the observed phenomena.

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Lerici is a beautiful little seaside town in the "Golfo dei Poeti," on the Tyrrhenian coast. The closest airports are Pisa (80km) and Genova (100km).

Pisa is connected daily to: Munich, London and Paris
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The trip takes about one hour. From La Spezia a bus will take you to Lerici in about fifteen minutes. A shuttle service to and from airports at the beginning and at the end of the Conference is being considered. More detailed information about travel and site are available on the Conference webpage.



VILLA MARIGOLA, Lerici (La Spezia, Italy)

Madness Abating Somewhat?

Latest reports would have us believe that the Great British mania for all things millennial is slowly becoming replaced by the equally great British indifference. Just a few months back, the media brimmed over with horror stories about £75 an hour millennium eve babysitters, and cab drivers demanding sums for chauffeuring that required weary New Year revelers to take out second mortgages if they wanted to avoid a long, cold walk home in the early hours of January 1, 2000.

There were rumors of erstwhile uninspiring hotels and restaurants tripling, or even quadrupling their prices over the festive season. But you can't pull that stunt on the Brits for long. The old fighting spirit emerges with a vengeance when they think they're being stung. So there are now lots of hotels with a surprising number of vacant rooms this New Year's Eve and, while Britain is far from becoming a nation of party-poopers, the majority appear to be making plans a little closer to home.

Much the same thing is happening with the other major U.K. event this year—the total solar eclipse on August 11. The hype in

the early part of the year was that so many millions were expected to flock to Cornwall and cram themselves into the narrow band of totality (see map) that the county, at worst, would drop off into the sea under the sheer weight or, at best, would be closed to the public once a safe capacity was reached.

Hotels were reported to be gearing up with every intention of turning this celestial free event into a real



down to earth moneyspinner. One householder advertised his property, right under "ground zero," for rent at a fee of £18,000 for the first two weeks in August. The proceeds, presumably, enabling him to hire a small luxury yacht and view the eclipse from somewhere less full of darned tourists!

Acres of farmland were to be turned into campsites, their owners demanding extortionate fees for Eclipse Week. But, again, the British B.S. detector clicked in. Few were willing to be packed like sardines at smoked salmon prices, so most voted instead to stay put, enjoy their allotted percentage of partial eclipse, and watch the black-out on the BBC from the comfort of their own lounges.

Millennium Watch continued on page 51

The Arthur C. Clarke Literary Award-1999

The 13th Annual Arthur C. Clarke Literary Award ceremony took place at the London Science Museum on Wednesday, May 19, 1999. This year's winner was 30-year-old American-born writer, Patricia Sullivan, for her novel *Dreaming in Smoke* (Spectra, ISBN 0553577034, \$5.99), which tells of human colonists dependent upon artificial intelligence for protection on an inhospitable world, and their struggle for survival when the main computer crashes.

The Award, set up by Sir Arthur in 1986 to encourage quality science fiction writing, is Britain's top accolade in the field and carries with it a cash prize of £1,000. It is jointly sponsored by the British

Science Fiction Association and the Science Fiction Foundation. *Dreaming in Smoke* was selected from among a total of fifty-five entries. From his Sri Lanka home, Sir Arthur said of this year's entries: "The judges were particularly impressed by the range of ideas in these books, which explore experience in both inner and outer space."



A.C.C. Awards Hostess Angie Edwards of Rocket Publishing
Photo: Soo Seddon

About Patricia Sullivan

Tricia was born in 1968 in New Jersey, the youngest of five children. She has a B.A. in Music from Bard College and an M.A. from Columbia University in Education of the Gifted. She worked for several years with disadvantaged, bright youngsters in New York City.

She started writing at a very early age—mostly, she says "horse stories" until the age of nine when, inspired by reading Tolkien, she switched to fantasy. Novelist Raymond Kennedy encouraged her to write in his classes, which she admits to attending mostly as a "nefarious means to get English credit without studying literature." The end result was her first book, *Lethe*, published in 1995, which was nominated for the John W. Campbell Award. She moved to England the same year. Her second, highly acclaimed book, *Someone to Watch Over Me*, was published two years later. Writer David Brin has praised her as one of the finest new talents in the field.

The Arthur C. Clarke is her first award. Of her winning work she says: "I absolutely despised it while writing it." She had committed to a publishing deadline but felt "psychologically exhausted" by *Someone to Watch Over Me* and didn't feel it was one of her best efforts. She even told her family and friends not to read it. Which—after winning Britain's most prestigious science fiction award—simply proves the point that authors are invariably their own harshest critics!

Her favorite among Clarke's works is *Childhood's End*, which she read as a teenager and was deeply affected by. Tricia is a charmingly modest writer. When asked what would be her reaction if Hollywood made encouraging noises her way, she responded that while, naturally, she'd like to make a lot of money, she'd prefer to shelter her work from that kind of pressure if she could. She added: "I suppose that's the big career impact of winning a prestigious award. It suggests that the book has a value out of proportion to its rather insignificant sales appeal, which means that perhaps my science fiction will find a small but loyal following, and then I can keep writing it. That's all I really want."



Winner, Tricia Sullivan, receiving her award from Paul Kinkaid, ACC Administrator.

Photo: Soo Seddon

"Gold's theories are always original, always important, usually controversial and usually right." That's the opinion expressed by Freeman Dyson in his foreword to this thought-provoking book in which Thomas Gold expands upon his early theoretical works on the origin of oil and natural gas^{1,2,3} and presents what, he claims, is compelling evidence for the existence of a heavily populated subterranean biosphere.

Gold believes hydrocarbons are primordial and have nothing whatsoever to do with fossil remnants. He explains the presence of biological matter in oil as contamination by thermophilic organisms which lived—and still live—at depths of up to 10 km below the Earth's surface at temperatures of around 100 °C.

Hydrocarbons, he states, "are not biology reworked by geology, but rather geology reworked by biology." He goes on to detail the likely food chain of these deep Earth, heat-loving microbes—how upwelling methane might provide them with a source of carbon and how oxygen could be extracted from iron oxides and sulphates in the surrounding rocks. Life sustained directly by chemical energy, he believes, is much more likely to have started within the Earth long before surface conditions were suitable for highly sophisticated processes like photosynthesis to evolve.

He suggests that there are possibly ten "worlds" within our own solar system where such life forms could be thriving right now. In June 1986, Gold was instrumental in persuading the Swedish State Power Board to drill down into the Siljan Ring, a 44 km wide meteor crater. If oil could be found beneath the Swedish granite—the last place any geologist would expect to find it—he would have evidence to support his abiogenic theory of hydrocarbon formation.

Drilling duly commenced and there were "good measurements made of hydrogen, helium, methane, and other hydrocarbons." Also found, at a depth of 6 km, was a layer of very finely grained magnetite bound together by a light oil. Experiments on this "foul-smelling black putty," conducted at the University of Oklahoma, led to the conclusion that the material was not a contaminant introduced by the drilling process. Microbes cultured from this sludge produced two previously unknown bacterial strains.⁴ When the well was finally pumped out, eighty-four barrels of crude oil were harvested.

Armed with his astonishing results, Gold approached the major science journals, all of which flatly refused publication. Some referees said his results were "totally incredible" and refused to take the experiment seriously until it was replicated by another team. They ignored Gold's argument that even a mere twelve tons of oil were "meaningful, especially when found in a location where, in the conventional view, not a single drop could have a rational explanation."

Deep Hot Biosphere is considered to be Gold's most controversial theory to date, but is certainly not the first to be cautiously regarded by his peers. The scientific fraternity (as any cold fusion researcher will confirm) doesn't take kindly to theories which challenge conventional thinking, and Gold even quite shamelessly commits the even deadlier sin of daring to speculate in realms outside his own sphere of expertise. What is even more distressing to his critics is that, with annoying frequency, many of his

allegedly off-the-wall ideas have eventually been proven correct.

Gold was one of the first astronomers in 1968 to come up with an explanation of the nature of the newly-discovered pulsars and accurately predicted the gradual slowing of their rates of spin. Even though this was his own field, his swiftly-offered explanation was considered by some of his colleagues to be a little too quick off the mark.

Two decades earlier, he irritated physiologists by attempting to undermine their understanding of mammalian hearing. He offered them a series of verifiable and easily reproducible test results, the validity of which they refused to acknowledge for forty years. Spurned for even longer was his 1955 theory on the instability of the Earth's axis—a concept which has only gained respectability within the last two years.

Gold, like Martin Fleischmann, is a highly respected Fellow of the Royal Society who is (equally) unafraid to regale fellow scientists with revolutionary concepts, however uncomfortable that might make them. On scientific myopia, Gold writes: "New ideas in science are

not right just because they are new. Nor are old ideas wrong just because they are old. A critical attitude is clearly required of every seeker of truth. But one must be equally critical of both the old ideas as of the new."

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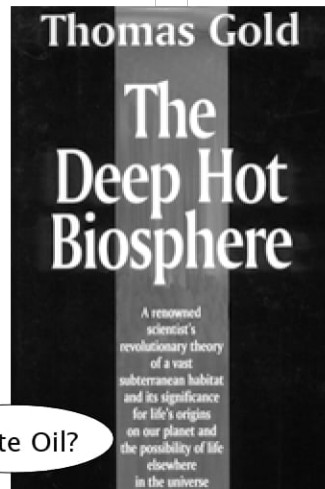
Millennium Watch continued from page 50

Thousands of millennium projects are now well underway throughout the U.K. I visited the showpiece Dome site in London, hoping to get a decent picture for *Infinite Energy* but, unfortunately, most of the area was still surrounded by scaffolding and builders' porta-potties, which sort of marred the overall effect. The Dome, which can hold up to 35,000 people at one time, will be officially opened by the Queen on New Year's Eve and, according to press handouts, will house an exhibition to rival the great one, although the centerpiece of that certainly wasn't a 90-foot high statue of an embracing couple—Queen Victoria most definitely would not have been amused.

Nearby Greenwich Park—home of the prime meridian line and the famous observatory—will be the venue for a mega-party. The BBC will be siting its international, outside broadcast unit there and will show scenes of revelry from around the world on giant screens erected around the Park. And, as ever, there will be the traditional Trafalgar Square bash.

Further information for would-be visitors is available by calling +44 181 846 9000 or on the English Tourist Board's web site (www.visitbritain.com).

The most bizarre millennium eve event I've seen in the press (and there have been quite a few!) appears to be one planned by the French. The Eiffel Tower is to be turned into an enormous chicken which will "lay" a giant egg. This grand oeuf will slowly descend the famous ironmongery to the beating of 2,000 drums and, at midnight, will "hatch," revealing hundreds of television monitors showing live pictures from millennium parties around the world. At the same time the Seine will be awash with several thousand brightly colored plastic fish which, according to a publicity brochure issued by the creators of the 650-foot Tour de la Terre to be erected by the river, will emerge to "interrogate each and every one as witnesses to the future." I'm strongly tempted to stick with my lounge and the BBC. □□□



Infinite Oil?

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A Letter Supporting COFE and Tom Valone

Editor's Note: Some encouraging news emerged from the recent attacks by members of the American Physical Society (APS) and certain media against the Conference on Future Energy (COFE). This conference was finally held in Bethesda, Maryland after being booted out of three (!) U.S. Government Departments (State, Energy, and Commerce) where it had been scheduled successively—see the article on COFE by Jeff Kooistra in this issue, pp. 9-15, as well as our report on the March APS meeting in IE No. 25. We received the following note from Tom Valone, organizer of COFE. It transmits the courageous letter supporting COFE by David Hamilton of the U.S. Department of Energy. Bravo to David and Tom!—EFM

This is a very gratifying letter showing that rational thought may prevail in the physics community and in the government eventually.

Thomas Valone, Patent Examiner 703-305-4912 CP4-8C05

From: David.Hamilton <David.Hamilton@ee.doe.gov>

Sent: Friday, June 25, 1999 11:01 AM

To: Valone, Thomas

To Whom it My Concern:

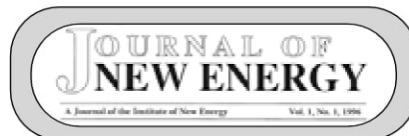
Thomas Valone has, in my opinion, demonstrated outstanding character and determination to carry out his mission and duties as a government official for the patent office. He has gone beyond the call of duty in his attempts to disseminate information and his recent work to organize the Conference on Future Energy (COFE) is a fine example. I find it unfortunate that some individuals are so negatively polarized on some of these topics, however their assault on Thomas Valone is totally unwarranted. The COFE provided a valuable service that facilitated communication between highly qualified scientists and engineers to review high-risk science with the public in an open forum. Investors of the private sector also participated and were able to gain insight from this communication between and the reviews of scientists who require funding. Granted, some of the topics had high risk, but it appears to be general consensus that the fringe areas of Nature are where the major advances in physics are expected. Mr. Valone, as a government employee, properly showed an open hand and no prejudice in reviewing such research. I participated at the COFE in my official capacity as a program manager for the Department of Energy to present a public programmatic overview of my programs and to review the science and technologies of others. As a result of the COFE, several low energy nuclear reaction experiments were discussed in detail between the researchers and several scientists, including those with nuclear backgrounds. Although I see this as a basic science, our discussion uncovered the possible complex nature of low energy nuclear reactions that may explain its elusive nature. The evidence analyzed showed a myriad array of chemical and nuclear reactions performing both endothermic and exothermic processes. Granted, there are materials and instrument error possibilities, but prejudice is not scientific grounds to dispel experimental evidence. Only rigorous analysis of the data, experimental setup, and instrumentation is a valid test. These are not the medieval times and scientific method, not opinion, should lead us into the future.

Sincerely, David B. Hamilton

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Washington, DC 20585

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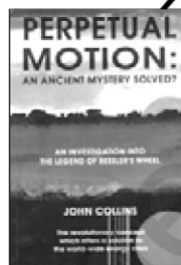


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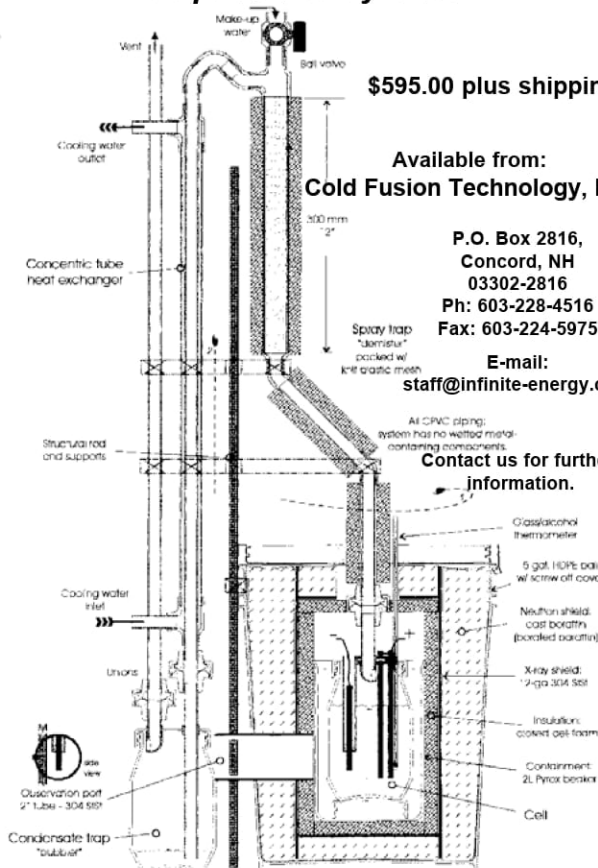
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Inside Zero Point Energy

Thomas Valone*

For the first time in history, a lot of media attention is being paid to the sea of energy that pervades all of space. It just happens to be the biggest sea of energy that is known to exist and we're floating inside it. (Credit due to *The Sea of Energy* by T. Henry Moray for the idea.) Not only is it big but its energy is estimated to exceed nuclear energy densities, so even a small piece of it is worth its weight in gold. What is it? Many people are not sure what "zero point energy" (ZPE) is. Most agree that virtual particle fluctuation contributes to it and van der Waals forces don't explain everything in ZPE-measuring experiments. Does it offer a source of unlimited, free energy for homes, cars, and space travel? Depending on who we talk to, ZPE can do everything or ZPE can do nothing useful. How can the energy be converted to a usable form? What are the basic explanations of ZPE and the new discoveries, which have rocked the U.S. Patent Office, *Physical Review Letters*, *Science*, *Scientific American*, and the *New York Times*? Why is ZPE implicated in the latest confirmation of cosmological antigravity? Can the Casimir effect be a source of energy? This article is intended to give a review of the latest developments (as well as an introduction to the topic for those who are non-specialists).

The Casimir Effect

Zero point energy has been called "the ultimate quantum free lunch" (*Science*, Vol. 275, 1/10/97). During the early years of quantum mechanics, Paul Dirac theorized that the vacuum was actually filled with particles in negative energy states (*Proc. R. Soc. London A*, 126, 360, 1930), thus giving rise to the concept of the "physical vacuum," which is not empty at all. Quantum mechanics also predicted that invisible particles could become materialized for a short time and that these virtual particle appearances should exert a force that is measurable. Hendrik B.G. Casimir (*Phys. Rev.* 73, 360, 1948) not only predicted the presence of such a force, but also explained why van der Waals forces dropped off unexpectedly at long range separation between atoms, predicting that $F=K/d^4$ where $K=\pi\hbar c/480$. Though the Casimir effect subsequently was verified using non-conductive plates, there was always a scientific need for a verification of the Casimir force using conductive plates based on Casimir's 1948 paper. For the first time, Dr. Lamoreaux, now at Los Alamos National Laboratory, performed the experiment with less than one micrometer (micron) spacing between gold-plated parallel plates attached to a torsion pendulum (*Phys. Rev. Lett.*, 78, 1, 97). In retrospect, he found it to be one of the most intellectually satisfying experiments that he ever performed since the results matched the theory so closely (within 5%).

The Casimir effect has been posited as a force produced solely by activity in the vacuum. The Casimir force is also very powerful at small distances. Besides being independent of temperature, it is inversely proportional to the *fourth power* of the distance between the plates! Therefore, as the plates are brought closer, the virtual particles *outside* the plates increasingly overpower the decreasing quantity of virtual particles appearing *between* the plates with an exponentially increasing force. (Also notable is the fact that its frequency dependence is a third power and the force can be altered with dielectrics or resonate with narrow-band mirrors—see *Phys. Lett. A*, 225, 1997, 188-194.) Lamoreaux's results come as no surprise to anyone familiar with

quantum electrodynamics (QED), but they serve as material confirmation of an unusual theoretical prediction of QED: the all-pervading vacuum that continuously spawns particles and waves that spontaneously pop in and out of existence. Their time of existence is strictly limited by the uncertainty principle, but they create some havoc while they bounce around during their brief life span. The churning quantum foam extends throughout the universe, even filling the empty space within the atoms. A diagram showing "The Shape of Nothing" (*The New York Times*, 1/21/97) is pictured to be not only subatomic, but sub-elementary particle in size. Physical theories predict that on an infinitesimally small scale far, far smaller than the diameter of an atomic nucleus, quantum fluctuations produce a foam of erupting and collapsing virtual particles, visualized as a topological distortion of the fabric of space-time.

Another implication for free energy from ZPE comes from the fact that Casimir also mentioned a *three-dimensional volume effect* (*Physica XIX*, 1956, 846). This has recently been used with the relativistic stress-energy tensor to analyze the quantum electromagnetic field inside any given volume. With a "relatively" simple calculation, it has been shown that as the electron density increases due to gravitational compression, there is an *energy creation*. "The energy output produced by the Casimir effect during the creation of a neutron star turns out to be sufficient to explain nova and supernova explosions" (Sokolov, *Phys. Lett. A*, 223, 1996, 163-166).

The *New Scientist* (July 1987, "Why Atoms Don't Collapse") gives an impressive endorsement of the importance of ZPE:

There is a dynamic equilibrium in which the zero point energy stabilizes the electron in a set ground-state orbit. It seems that the very stability of matter itself appears to depend on an underlying sea of electromagnetic zero point energy.

The Lamb Shift

Another historically valid test in the verification of ZPE has been what's been called the "Lamb shift." Measured by Dr. Willis Lamb in the 1940s, it actually showed the effect of zero point fluctuations on atomic levels. The electrons are slightly shifted upwards in their atomic orbits. (The implications of the Lamb shift were never fully explained when I took quantum mechanics except that the professor was forced to mention God as he tried to explain the "all-pervading electromagnetic field" which caused the problem.) Physicist Margaret Hawton describes the Lamb shift as "a kind of one-atom Casimir Effect" (*Phys. Rev. A*, 8/94) and predicts that the vacuum fluctuations of ZPE need only occur in the vicinity of atoms or atomic particles, which seems to agree with Dr. Koltick's findings cited above.

The ZPE fluctuations are fundamentally based upon the uncertainty principle, which has been predicted to be "signed into law" someday soon, since no violations have so far been found. Furthermore, the majority of physicists today attribute *spontaneous emission* and the Lamb shift *entirely* to ZPE (as noted in Hawton's paper). This may lead everyone to believe that, though it is random, it can no longer be called "spontaneous emission" but instead should properly be labeled "stimulated emission"—much like laser light is stimulated emission, even though there is a random quality to it. Textbooks on quantum

theory already agree with this new interpretation:

The smallest possible energy of the field corresponds to the presence of one-half quantum per state. This suggests that we regard the spontaneous emission as being induced by the zero point oscillations of the electromagnetic field; note, however, that these oscillations are twice as effective in producing emissive transitions as are real photons and are of course incapable of producing absorptive transitions. (Schiff, *Quantum Mechanics*, 3rd edition)

The Classical Vacuum

One of the best educational viewpoints on ZPE has been given by Dr. Timothy Boyer, in an article entitled, "The Classical Vacuum" (*Sci. Amer.*, 8/85, p. 70). Boyer, a well-published and highly respected physicist, describes all of the features to be expected from ZPE, including the frequency spectrum, even in a moving reference frame, as well as the energy and force. Boyer traces the historical "creation of the vacuum" as proceeding in stages in parallel with the historical development of ideas about the vacuum. To paraphrase, he says that in the seventeenth century it was thought that a totally empty volume of space could be created by simply removing all matter—in particular, all gases. That was our first concept of the vacuum. Just get rid of all the gas. Late in the nineteenth century, it became apparent that the region still contained *thermal radiation*. But it seemed that the radiation might be eliminated by cooling. So the second concept of getting a real vacuum is to cool it down to zero temperature. Just go all the way to *absolute zero*. Then we've got a real vacuum. Since then, both theory and experiment have shown that there is a non-thermal radiation in the vacuum and that it persists even if the temperature could be lowered to absolute zero. Therefore, it was simply called the "zero point" radiation. Further proof is evident, as Dr. Forward points out in his tutorial below, when physicists have cooled helium to within *microdegrees* of absolute zero and still it remains a liquid! Only ZPE can account for the source of energy that is keeping helium from freezing.

Another aspect of the vacuum is that the constant virtual particle flux of the vacuum ZPE can become less virtual (short-lived) near the boundaries of bigger particles, with atomic number $Z=137$ or higher. This is because the intense electric field gradient causes a more prodigious decay of the vacuum when the binding energy equals or exceeds the rest mass of the electron. Furthermore, if superheavy atoms are created with $Z=173$, the binding energy then exceeds twice the rest mass of the electron and pair production ensues with matter and anti-matter appearing out of the vacuum. The electron is driven into the nucleus and spontaneous positrons (anti-electrons) are produced, constituting a *true source of free energy*.

Paradoxically, the vacuum near an over-critical charge is a vacuum that cannot be emptied. (*Scientific American*, Dec. 1979, p. 150)

Such a physics discovery certainly vindicates the name of *Infinite Energy* magazine.

It is interesting to note that the above-mentioned phenomena was first labeled the "Klein paradox," when the Klein-Gordon equation mysteriously predicted the "reflection" of an electron with more energy than the incident electron with a *simultaneous* "transmission" of the particle into a negative kinetic energy state, only if the voltage barrier exceeded $2mc^2$ or twice the particle's rest mass (Klein, *Z. Phys.*, 53, 157, 1929). In retrospect, this paradox helped physicists decipher a free energy

source much as I hope the runaway solution of the Lorentz-Dirac equation will do someday.

ZPE Tutorial

For those who may want more scientific detail, a tutorial and derivation of ZPE follows. In his papers, Dr. Hal Puthoff discusses the fact that the existence of the electromagnetic zero point fluctuations is a clear prediction from quantum theory resulting from *quantization*. Basically, quantum mechanics simply deals with compartmentalizing energy and compartmentalizing matter. So really what we're talking about is "quantization of matter and energy." That's all we need to presume in order to derive the existence of zero point energy! What Dr. Robert Forward does in his very interesting Phillips Laboratory Report entitled, "Mass Modification Experiment Definition Study" (No. PLTR 96-3004), reprinted in *Infinite Energy* No. 9, is to help us understand the simple harmonic oscillator basis of ZPE:

Quantum Lesson 101: We have two categories of phenomena that we're dealing with: 1) matter quantization and, therefore, "matter zero point fluctuation" as well as 2) energy quantization and, therefore, energy or "radiation-type" quantization. That's the first lesson to keep in mind.

In regards to the material aspect, inside an atom, or inside matter (picture a crystal), we can actually use the equation applied to a spring, which is the standard force F equals the square root of k over the mass m . Now k normally designates the spring constant. In this case we're using it as the spring constant of the electron cloud, which is the electron cloud acting as a spring in a crude terminology, to react to the mass of the nucleus of the atom. And, of course, there is a little bit of give and take here. We have both attractive and repulsive forces that are at play, and the natural frequency of vibration is going to be quantized only if we're looking at the material part of it. So, as we derive this in the quantum mechanical viewpoint as physicists say, "the formality" (the formal approach to translating into quantum mechanics), we get the Einsteinian equation, $E = hf$. This relates energy to frequency in terms of Planck's constant (h).

These are very simple equations, so far. What they do is describe the vibrational quanta in matter and also the radiational portion, the photons, in the vacuum. As Dr. Forward mentions in his derivation, when equations of quantum mechanics are used to determine the *average energy* (with a bracket on both sides of the E) of the vibrations of the atoms, the answer is $E = n(T) + hf/2$. Therefore, when T goes to zero, then the number of phonons or photons that are being created also goes to zero.

Thus even at zero temperature quantum mechanics predicts that each of the atoms will still have an average residual energy (as we can see if we let n go to zero) of $hf/2$. Physicists have been grappling with this for years, because there appears to be an infinite amount of energy available if f is allowed to increase without limit. Ever since Casimir predicted it and various other scientists have verified it, this simple equation is really all that is underlying the theory of the zero point field and zero point fluctuation. What's funny about it is that the $1/2$ factor is there, which is a little bit deceiving. However, we have to keep in mind, as Dr. Forward points out too, that the real equation is $E = hf$. (Rigorously, quantum field theory performs an infinite sum over eigenvalues of zero point field modes to obtain the vacuum energy (see "Absence of a Zero Point Ambiguity," *Phys. Lett. B*, 358, 1995, 56). So, we're dealing with an amount of energy, on average, that is available to only half the quanta. Another phrase called "partons" is used by Puthoff to indicate the smallest quanta of vibration oscillators: Planck oscillators that are available in a vacuum or in matter. Therefore, instead of

half-photons or half-particles existing everywhere, we're looking at only half of the possible photons or particles really being materialized at any one time.

More tutorial information on ZPE is also available in the two-hour video for which I was the technical consultant, "Free Energy: The Race to Zero Point," produced by Lightworks Audio and Video, and also available from Integrity Research Institute and *Infinite Energy*.

Cosmological ZPE

Recently, ZPE was mentioned in *Science* (Vol. 282, Dec. 18, 1998, p. 2157) in an article called the "Breakthrough of the Year." Two teams of astronomers have confirmed that distant galaxies are *accelerating* apart. Furthermore, two-thirds of all astronomers now acknowledge that the data is valid. Thus, the cosmological constant envisioned by Einstein is being reconsidered and an *antigravity force* is being postulated. Physicists have also interpreted the force as "the evanescent particles that flicker in and out of existence in 'empty' space that gives space its springiness, shoving it apart." *Scientific American* seems to agree ("Cosmological Antigravity," January, 1999, p. 53): "The aggregate energy represented by these 'virtual' particles, like other forms of energy, could exert a gravitational force, which could be either attractive or repulsive depending on physical principles that are not yet understood." The cosmological constant represents energy inherent in space itself and *coincidentally* is almost exactly equal to the average density of ordinary matter in the universe (10^{-29} gm/cc), at this particular time in cosmic evolution.

To help explain the concepts raised above, it is important to mention that a *repulsive* Casimir force may be experimentally obtained in the lab by utilizing a cavity built with a dielectric and a magnetic plate (see Boyer, *Phys. Rev. A*, 9, 1974, 2078 or Kupiszewska, *J. Mod. Opt.*, 40, 1993, 517). Thus, the cosmological effects may be easier to explain than the popular journals are indicating at this time.

Theoretical insights may also be gained from *Subquantum Kinetics* by Dr. Paul LaViolette, whose open system model of space permits localized ether concentration wave patterns (particles) to emerge in relation to the substrate field potential. This systems science approach to cosmological and microphysical phenomena regards space as a vast nonequilibrium reaction-diffusion medium, offering new insights.

Experimental ZPE

Since ZPE is due to virtual particle flux and high electric field gradients cause the flux to increase, it is reasonable to assume that near the surface of an electron, the ZPE virtual particle flux would be very high, like a bunch of flies buzzing around it.

Science News reports (2/8/97), "Since the 1930's, theorists have proposed that . . . virtual particles cloak the electron, in effect reducing the charge and electromagnetic force observed at a distance." Therefore, for the first time, Dr. Koltick (*Phys. Rev. Lett.*, 1/20/97) performed an experiment designed to *penetrate the virtual particle cloud* surrounding the electron with a particle accelerator at energies of 58 gigaelectronvolts, without creating other particles. From his data, the newly obtained value of the fine structure constant is $1/128.5$, instead of the smaller $1/137$ that is traditionally observed for a fully-screened electron. The fine structure constant equals the electron charge squared divided by Planck's constant and the speed of light.

As to the concept of *free energy from ZPE*, one of the first journal articles to investigate the possibility is: "The extracting of electrical energy from the vacuum by cohesion of charge-foliated conductors" (*Phys. Rev. B*, 30, 4, 84). Dr. Forward describes this "parking ramp" style corkscrew or spring as a ZPE battery

that will tap electrical energy from the vacuum and allow charge to be stored. The spring tends to be compressed from the Casimir force, but the like charge from the electrons stored will cause a repulsion force to balance the spring separation distance. It tends to compress upon dissipation and usage, but expand physically with charge storage. It is similar to the multilayer mirror in the article, "The Casimir Force for Passive Mirrors" (*Phys. Lett. A*, 225, 1997, 188) or the "Casimir Forces Between Beads on Strings and Membranes" (*Phys. Lett. B*, 347, 1995, 56) where virtual particle exchange between the beads is analyzed. It seems that any closely spaced matter in the submicron range will invoke the Casimir force. The last article could be useful for ZPE experimentalists, since the Casimir force equations provided for the N "beads" allow them to be stuck on a membrane or freely placed, with a variable D for the spatial dimension of interest.

Since the ground-breaking work on the "one-atom micro-maser" (*Phys. Lett. A*, 217, 1996, 219), such concepts as "virtual photon tunnel effect" and "virtual photon quantum noise" are being explored. Further work is also suggested by the finding that "pressing zero point energy out of a spatial region can be used to temporarily increase the Casimir force" (Weigert, *Phys. Lett. A*, 214, 1996, 215). This article describes the process of squeezing energy states in quantized electromagnetic fields to distribute the uncertainty over position and momentum at will. In fact, a future job market may be opening for the "quantum mechanic" or the vacuum engineer now that such precision in ZPE is emerging.

Dr. Forward subscribes to the classical notion that there is no known limit to the electromagnetic wavelength or frequency in the vacuum. What we see from Dr. Puthoff's approach to this is that he supports the majority view of a cutoff, which is based on Sakharov's work. The cutoff frequency (perhaps considering $hf=mc^2$) is called the *Planck frequency*, which is around 10^{43} Hertz. This opposes what we see as far as Moray King (in *Tapping the Zero Point Energy*) and Dr. Forward are saying: that there is an infinite amount of energy available. In a later section we will see that Dr. Puthoff's theory derives gravity, inertia, heat, and also electricity directly from ZPE considerations. Dr. Forward suggests using micro-fabricated sandwiches of ultrafine metal dielectric layers. He believes that ZPE may have definite potential as an energy source.

Another possible experiment for ZPE is the "Casimir Effect at Macroscopic Distances," (*Phys. Rev. A*, 48,1,93) which proposes observing the Casimir force at a distance of a few centimeters using confocal optical resonators within the sensitivity of laboratory instruments.

To summarize, the experimental evidence for the existence of ZPE is: 1) the Casimir Effect, 2) the Lamb shift, 3) van der Waals forces, 4) diamagnetism, 5) spontaneous emission, 6) microdegree liquid Helium, 7) quantum noise, and, most recently, 8) cosmological antigravity. Awaiting experimental verification is that inertia and gravity are also proof of ZPE.

The First ZPE Patent

History was made on December 31, 1996, when for the first time ever, ZPE was the subject of a U.S. patent (No. 5,590,031), reprinted in *Infinite Energy* No. 11. Dr. Frank Mead, from Edwards Air Force Base, has designed receivers to be *spherical collectors* of zero point radiation with hemisphere reflectors of beat frequencies. He states,

Zero point electromagnetic radiation energy, which may potentially be used to power interplanetary craft as well as provide for society's other needs, has remained unharnessed.

Proposing to convert zero point electromagnetic radiation to electrical energy, Dr. Mead grapples with the high frequencies that may extend up to around 10^{40} Hertz. (To gain a perspective, gigahertz radar is only 10^{10} Hz or so. Visible light is about 10^{14} Hertz and gamma rays reach into the twentieth power, where the wavelength is smaller than an atom.) With slightly different sized receivers, the system produces a *beat frequency*. A difference frequency is produced with the rest of the circuitry amplifying that lower “step-down frequency.” For example, if one part in a million accuracy was achieved in making the microspheres, then the subtraction of two 10^{20} Hz signals would yield a 10^{14} Hz beat frequency. However, I have recommended to Dr. Mead a real step-down frequency involving “frequency division,” which would mean less accuracy is required in the machining of the hardware and a bigger difference in the frequency output. The important part of his design is that the physical apparatus itself, whether a conductor or dielectric, is responding to the frequencies that it resonates with ZPE. Similar to the passive mirror article cited above, Mead realizes that the physical design of the conductor will determine resonant characteristics. If large spheres are used, then it would resonate with very long, low energy frequencies. However, he points out that if this is miniaturized (nano-lithography, down to sub-micron levels), then as the frequency cubed (f^3) dependence goes up very fast, the energy density becomes much higher. The implications are that not only can it be made as a solid state device, but the smaller you make it, *the better it is*. In fact, Mead has confided that he is interested in working with single particles like protons or neutrons that may be slightly different by only parts per trillion, for example. This raises the question of what type of antenna would be appropriate for such an atomic resonator. So there is a lot of potential for this invention and I think we’re going to see other follow-up patents.

As to understanding the concepts behind ZPE, Frank Mead calls it “zero point electromagnetic radiation energy.” Dr. Lamoreaux wants to refer to it as “a flux of virtual particles,” because the particles that react and create some of this energy are popping out of the vacuum and going back in. That is another viewpoint. And of course *The New York Times* simply calls it “quantum foam.” But the most important part about it, from Dr. Robert Forward’s excellent paper, is that “the quantum mechanical zero point oscillations are real.”

ZPE and Sonoluminescence

Does sonoluminescence tap ZPE? This question is based upon the experimental results of ultrasound cavitation in water which emit light and extreme heat. “The Chemical Effects of Ultrasound” (*Scientific American*, 2/89) explains how bubbles, 100 microns in diameter, can implode violently, creating temperatures of $5,500^\circ\text{C}$, or about the temperature of the sun’s surface!

Physicist Seth Putterman from UCLA explains in “An Expanding Knowledge of a Tiny Bubble’s Burst” (*Washington Post*, 8/5/96) that there is enough energy in the one mile per second shock wave to tear electrons off the vapor atoms in the water (ionizing them) and heat them to light-emitting levels. Apparently, the *presence of argon* dissolved in the water is a crucial ingredient for the visible/ultraviolet light to glow brightly. Critical to the understanding of the nature of this light spectrum, however, is whether it matches the known spectra of ionized gases. Dr. Claudia Eberlein in her pioneering paper, “Sonoluminescence and QED” (*Phys. Rev. Lett.*, 76, 3, 842, 10/96), concludes that *only* the ZPE spectrum matches the light emission spectrum of sonoluminescence, which therefore must be a ZPE phenomenon.

This helps explain devices such as Grigg’s Hydrosonic

Pump, whose water glows blue when in cavitation mode, and which consistently has been evidencing an over-unity performance with excess energy output (*International Symposium on New Energy*, Denver, 1996, and U.S. Patent No. 5,188,090).

The *Post* article also discusses the possibility of the heat being sufficient for cold fusion, in its review of the movie “Chain Reaction” starring Keanu Reeves. (This movie is highly recommended because it is the first movie ever made to actually mention the words “free energy.”) The movie, which was featured as a cover story for Issue No. 8 of *Infinite Energy* magazine, shows the demonstration of a water fuel cell and the concept behind the frequencies and the power availability that makes it threatening. Who I find memorable is Morgan Freeman; he acts as the banker’s representative, a veritable archetype of J.P. Morgan resurrected from the life of Nikola Tesla. When he talks about the concept of free energy, he says, “That’s a noble concept, but it would cause the collapse of the world’s economies. . .” This reminds us of how the utilities have a vested interest in energy consumption—at least *paid* energy consumption.

Sonoluminescence and cavitation create the necessary shock waves to access zero point energy, but some scientists claim that one hundred times more heat is needed to create fusion. However, some cold fusion scientists who use “high pressure” cold fusion in cavitation devices say that they have achieved that requirement. The January 1997 issue of *IEEE Spectrum* cites UCLA physicist Robert Hiller’s calculation that the black body equivalent of the sonoluminescence radiation corresponds to a temperature of $100,000^\circ\text{K}$. The Yam article from *Scientific American* (12/97) continues the work of the late Noble prize winner Julian Schwinger and states,

Basically the surface of the bubble is supposed to act as the Casimir force plates; as the bubble shrinks, it starts to exclude the bigger modes of the vacuum energy, which is converted to light.

Scientists at UCLA have recently measured the length of time that sonoluminescence flashes persist. Barber and Putterman discovered that they only exist for *50 picoseconds* or shorter, which is too brief for the light to be produced by some atomic process (*IEEE Spectrum*, 1/97). Atomic processes, in comparison, emit light for at least several tenths of a nanosecond, which leads many to appreciate Eberlein’s proposal that ZPE is the source of the radiation.

Dr. Harold Puthoff’s ZPE

Dr. Harold Puthoff is a physicist who has continued to develop Dr. Andrei Sakharov’s theories of gravity and inertia. What he has achieved, which is now causing shock waves even at NASA, is that gravity has now been theoretically proven to relate directly to ZPE. Thus, a very fascinating new theoretical imagery is presented. For example, Dr. Puthoff, in his paper “Gravity as a Zero Point Fluctuation Force” (*Phys. Rev.*, 3/89), points out that gravitational mass and its associated gravitational effects are shown to derive in a self-consistent way from *electromagnetic zero point induced particle motion* (in other words, ZPE). “Zitterbewegung” or particle jittering may also be the result of that zero point fluctuation. Puthoff believes that it constitutes an already unified field. He refers to the *Gravitation* text by Misner, Thorne and Wheeler, often used in graduate courses on general relativity. There are basically *six approaches to gravitation* that are outlined in that book. The one that Dr. Puthoff emphasizes is specifically the one that Sakharov developed. In the paper, “Gravity as a Zero Point-Fluctuation Force” (*Phys. Rev. A*, 39, 5, 1993), he points out that Dr. Sakharov regards gravitation as not a fundamental interaction at all, but an *induced effect* that’s brought about by changes

in the vacuum when matter is present. The fascinating part about this is that the mass is shown to correspond to the kinetic energy, the zero point-induced internal particle jittering, while the force of gravity is a long-range effect. Low frequency, long-range forces are now associated with van der Waals forces. (Van der Waals forces are seen in colloids and various other liquids weakly interacting.) In Puthoff's theory, gravity is related directly to zero point fields, by the low frequency end of the zero point radiation spectrum.

When we consider ZPE as having a third-order dependence on frequency, it reminds me of the Hutchison effect (see *Introduction to 'Free Energy: The Race to Zero Point,'* report published by Integrity Research Institute), which also has been shown to be a third derivative (third-order) effect. The Hutchison effect is used to explain an object (conducting or non-conducting) which repels gravity under the influence of high-voltage AC-modulated DC fields, with the object continually and *uniformly* increasing its acceleration. Scientists have never seen that happen before except in the third-order Lorentz-Dirac equation treating radiation reaction, which may help explain the Hutchison effect. Forces in nature tend to create a *constant acceleration* (due to $F=ma$). The third-order effect predicted by the equation of motion in Puthoff's paper is directly related to zero point energy and also yields an insight into the Hutchison effect. It is also worth noting that the "Free Energy: The Race to Zero Point" video depicts the evaluation of the Hutchison effect by the U.S. military, which promptly classified the report.

Inertia is a ZPE Effect

The Lorentz Force is used to describe Faraday's Law, for example, when we have a charged particle moving in a perpendicular magnetic field and use the right hand rule to describe where the magnetic field is going to force that particle to go. In this example, the electric field, magnetic field, and the force are all perpendicular to each other. The Lorentz Force now has been proven by Puthoff in his derivation in *Physical Review A* (49, 2, 1994), to be directly responsible for what he calls the "electromagnetic resistance arising from the known spectral distortion of the zero point field in an accelerated frame."

Physicists often hear that Einstein was very interested in Mach's principle. Ernst Mach was a philosopher more than a scientist. He developed the concept that we could only understand inertia if we have some unmoving reference frame. He chose the distant stars as that reference frame. This has been interpreted, not only by Einstein but by others since then to actually explain the principle of inertia, since from our perspective the distant stars can be regarded as a relatively stable reference frame in the universe. Puthoff states, "The ZPF could thus serve as the Machian cosmic reference frame. . . and the interesting point is that the bulk of the contribution to the effect, in this case the inertial mass, comes from the very-high-frequency components of the ZPF." He then demonstrates a causal and quantifiable basis for Mach's principle and explains that the magnetic component of the Lorentz Force arises in ZPE and matter interactions.

Newton's Second Law is a ZPE Effect

Another theoretical breakthrough by Puthoff is the derivation of Newton's Second Law ($F=ma$) from ZPE electrodynamics. It appears to be related to the known distortion of the zero point spectrum in an accelerated reference frame. We, therefore, have an understanding about why force and acceleration should be related, and we gain insight into what is mass. Puthoff explains that the resistance to acceleration defines the inertia of matter and it appears to be an electromagnetic resistance. To summarize: according to the Puthoff theory, inertia is a distortion at high frequencies, while

gravity has been shown to be a low frequency effect.

The distortion of the ZPE field under acceleration is the cause of inertia that we feel from the bound electrons in our body reacting to the sudden change of direction, according to Puthoff. Perhaps there are ways to prevent that interaction. Maybe there are some ways that we can actually "turn on a dime," accelerate very quickly, and also take off on a space drive. In his book, *3001: The Final Odyssey*, Arthur C. Clarke believes that this is what may constitute a space drive. He specifically cites Dr. Puthoff's theory. Clarke pointed out years ago that though earth is the cradle of civilization, mankind cannot live in the cradle forever!

ZPE Critical Acclaim

Certainly such an impressive theoretical achievement as Puthoff's cannot go unnoticed. Philip Yam, in "Exploiting Zero Point Energy" (*Scientific American*, 12/97), addresses the issue critically. He admits that, "Energy in the vacuum. . . is very much real." Yam also explains, "Specifically, zero point energy emerges from Heisenberg's uncertainty principle, which limits the accuracy of measurements. . . Residual energy must therefore exist in empty space. . . And given the equivalence of mass and energy. . . the vacuum energy must be able to create particles. They flash briefly into existence and expire within an interval dictated by the uncertainty principle." He then goes on to dryly summarize the Casimir effect and Puthoff's research, with a demand for proof of principle.

Dr. Marc Millis of NASA's new Breakthrough Propulsion Physics Research Program has also addressed the above "emerging technology" in several articles in the past year, including his "Challenge to Create the Space Drive" (*J. Prop. & Power*, V. 13, No. 5, 1997, p. 577). There his search for asymmetrical modifiers led him to consider the "Remaining Research" of the ZPE field (which he calls the ZPF) "because of its high-energy density." Dr. Millis states, "Electromagnetism is also suggested as a target phenomenon for space drive research because of the ZPF. The ZPF is an electromagnetic phenomenon. Discovering any way to react asymmetrically with the ZPF would likely create a space drive." Further on he concludes, ". . . these theories provide new, alternative approaches to search for breakthrough propulsion physics."

Perhaps we can start a new trend by blaming everything on ZPE (pronounced "zippy")! For an interesting theoretical physics paper on zero point energy, download from <http://xxx.lanl.gov/abs/hep-th/9901011>.

Finally, Dr. John Bahcall from the Institute for Advanced Study at Princeton (where Einstein worked) offers this: "We are all quantum fluctuations. That's the origin of all of us and of everything in the universe."

About the Author



Physicist, author, retired college teacher, and licensed professional engineer, Mr. Valone has two books and over fifty articles in print. Recently, he was the technical consultant to the video, "Free Energy: The Race to Zero Point." Mr. Valone also is the President of Integrity Research Institute, which apparently struck a nerve with the First International Conference on Future Energy, causing disparaging articles in *Nature* (3-12-99) and *Science* (6-21-99). Serving in a Commerce Department post, Mr. Valone advocates freedom of scientific speech in the United States.

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Neutron Formation by Electron Penetration of the Nucleus

Thomas E. Phipps, Jr.*

Abstract

Experimental evidence recently reported by Conte and Pieralice suggests that electrons can penetrate nuclei to form neutrons. Theories by Mills, Conte, or Santilli might fit with this. Here, another theory to the same effect is deduced from a generalization of quantum mechanics proposed in 1960. The present non-relativistic calculation suggests the transitory existence of quasi-bound states described by wave functions of radial extension an order of magnitude less than the Bohr (atomic) radius. These might be precursors to neutron formation attendant on cold fusion. The present discussion is mainly an introduction to the ideas behind the eigenvalue calculation. Known limitations of that calculation, which is given in the Appendix, are emphasized.

Introduction

The process of K-capture and its inverse, whereby electrons enter and emerge from nuclei via so-called "beta processes," is well-known empirically since the earliest days of nuclear physics. To all appearances, an electron external to a proton in a nucleus spontaneously enters the proton, converting it to a neutron, or leaves the neutron, converting it to a proton. That's what a layman would say is happening. But contemporary physicists are aware of no mathematics to describe the implied presence of an electron within the nucleus or hadron on the size scale of the proton. Ergo, it can't happen. Instead, the math they do possess, incorporating the Heisenberg uncertainty principle, $\Delta x \cdot \Delta p \geq \hbar/2$ tells them that when the spatial confinement Δx approaches nuclear dimensions the momentum spread Δp becomes so large that the electron must bust out of the nucleus before it rightly gets into it.

So how do conventional physicists explain the beta processes mentioned above? Well, they had a brief fling with quantum mechanics (a sort of one night stand) but their real love, their enduring passion during the twentieth century, is field theory. And field theory, married to the sort of madcap ad hockery that produced "second quantization," induces them to *postulate* that the electron emerging from the nucleus is *created* in the act of emergence . . . and is *annihilated* in the inverse process. Yes, you heard that right. Physicists are very solemn, self-centered people. Throughout their merriest leg-pullings and pil-pullings they never laugh at themselves. Rather than change their existing math (a free creation of the human mind), they are happy to change the world to fit whatever parasitic math may be needed to perpetuate their old math. Thus, what *seemed* to be plain empirical evidence for sustained existence of electrons in nuclei was actually an occasion for extra postulation, aimed at sustaining the original Heisenberg uncertainty postulate.

Such gratuitous postulating is devastating to logical economy. But the mathematicians who have taken over physics in this past century are oddly indifferent to logical economy. Within their own purely mathematical culture, postulates come free of charge, along with arbitrary definitions. But pure mathematicians of the more refined breed, to keep up appearances, do make an attempt to keep their postulates mutually compatible. When their spiritual brethren move over into physics, however, they drop such small-minded hobgoblin constraints. There is no

compatibility between the postulate of creation/annihilation and the notion of continuously sustained existence implicit in wave equations descriptive of *stationary* (pure) states. Nor is there any compatibility between wave equations and the postulate of "wave function reduction" by which quantum measurement theorists contradict the postulates giving rise to the Schrödinger description of stationary atomic states. Thus, in modern physics compatible postulates are long passé.

A better approach to all difficulties created by the postulate system embodying Heisenberg uncertainty would be to find some modification of quantum mechanics consistent with the undeniable successes of that discipline that would allow electrons to exist in stationary states on more confined physical scales than are permitted by the Heisenberg postulate. At first sight that may sound like a contradiction in terms: Is not the Heisenberg postulate the essence of quantum theory? I suggest not. The physical essence is stationary states, described by eigenvalue equations. It is these that allow atoms to exist. And we know that nuclei, protons, etc., exist. . . so why not describe them by stationary states? The answer is that the latter are dynamical in pedigree and physicists lack the math to describe a truly nuclear dynamics. They try to fake it with group theory, symmetry properties, etc.—all of which reflect properties that must fall out naturally from a comprehensive dynamics, but that cannot by themselves honestly substitute for such a dynamics. The Heisenberg postulate is just one possible means to the end of describing stationary states via dynamics.

If physically shrunken stationary states could be discovered (mathematically), this would eliminate the need to postulate particle creation and annihilation. Nuclear beta processes could then be interpreted, like other electronic processes, as *changes of state*—with neutrinos possibly being the radiated quanta associated with electronic changes of state between nuclear-bound and free states. Changes of state are the essence whereby classical quantum theory describes observable happenings . . . and it would certainly improve logical economy if this essence could be invoked without need for ancillary postulates that flout it. After all, when an electron comes out of a hydrogen atom or a physicist comes out of the john, we do not say that the entity involved has been discontinuously "created" in the act of emergence; nor do we introduce an *ad hoc* "creation operator" to describe the occurrence. We simply say the atom has been ionized and the electron (or the physicist) has changed its state of motion from a confined state to a free one. Are we to suppose nuclei so different from atoms and physicists that the whole rule book of physical "existence" must be rewritten in their honor? And if it must, are we justified in assuming that our mathematical experts (those who have shown themselves expert in creating mutually contradictory postulate systems) know enough about the physics of nuclei not to botch the job of rewriting? "Trust us," they say. "Trust us, there is no such thing as electrons in nuclei. Trust us, there is no such thing as cold fusion."

So, what about those shrunken states of electrons in the vicinity of protons? Several contributors to this magazine have made proposals in this area. There are the "hydrinos" of Randall

Mills.¹ Or there is the “generalization of Schrödinger’s equation using biquaternions” suggested by E. Conte.² Or there is the conceptually related program of quantum mechanical generalization (“hadronic mechanics”) that R. M. Santilli^{3,4} and his school have developed over the years. Or, the reason I am writing this, I have my own generalization of quantum mechanics^{5,6} originally published in 1960. This last will provide the basis for my subject matter here. But I wish to emphasize that I write only because of new experimental evidence recently adduced by Conte and Pieralice,⁷ which hints that physical variables such as pressure, possibly attainable through confinement within a hydrogen-loaded solid-state lattice (palladium), may induce electron transitions to the shrunken states (bound to protons in nuclei) here hypothesized. This evidence might advance by one significant step the unraveling of the cold fusion mystery.

Finally, there is the important book by Mizuno,⁸ in which from extensive observations he concludes that the most reasonable theory may be *electron capture into nuclei*. As I see it, on this basis, the very non-reproducibility of cold fusion results is evidence of at least a two-stage process, in which, say, 1) electrons under pressure in a suitable solid state environment go into proton-centered shrunken electronic states that ultimately convert protons to neutrons. Then 2) the neutrons either transmute their host element or, if emitted, react with suitable nuclei in their vicinity to produce either fusion or fission. Both of these stages may preferentially occur near the surface of the palladium or pressure-exerting host material. It requires no expertise in the theory of rare events to recognize that a two-stage or multi-stage process has a much broader statistical spread of outcomes than does a single-stage process. Thus, it is specially sensitive to experimental conditions.

In the experiment of Conte and Pieralice,⁷ energetic electrons from an external radioactive source drove themselves into proton-containing material within an electrolytic cell. Neutrons were produced and were counted at well above background rates. According to those authors, their experiment “indicates the nuclear fusion of the proton and electron into a neutron.” I choose to accept this interpretation. Then the shrunken electron states may be supposed to exist and the Heisenberg postulate must be ousted from its shrine and demoted to its natural place in history beside all the other semi-successful descriptions of nature mankind has devised.

Accordingly, the observed excess heat in cold fusion reactions is viewed as not primarily the result of deuterons fusing within a palladium lattice. Instead, the pressure on electrons resulting from heavy electrochemical loading with hydrogenic atoms causes some electrons to make transitions to states shrunken in size to the order of some multiple of the electron Compton wavelength (4×10^{-11} cm), from which states further transition to genuinely nuclear (or hadronic) states of the order of the classical electron radius (2.8×10^{-13} cm), resulting in neutron formation, presumably have an enhanced probability of occurrence. The resulting neutrons, replacing protons in moderately high-Z nuclei, could destabilize those nuclei to produce fusion, fission, or transmutation of elements present in the cell. It is possible that such neutron-induced secondary reactions yield most of the observed excess heat.

Such a model might account for a) the heat, b) the transmutations, and c) much of the variability (non-reproducibility) characterizing observed cold fusion or chemically-assisted nuclear reactions (CANR). Well . . . it may be nutty (indeed, it doesn’t readily account for certain observed empirical features such as helium production), but it’s merely one competitive brand of nuttiness, a “dynamical” brand, to be compared with what field theory and group theory have to offer—which, in

respect to cold fusion, is nothing. An immediate consequence of this model, which may contradict observation, is that hydrogen ought to be approximately as effective as deuterium as a lattice loading agent. That is, atoms formed from protons alone and from protons in nuclear association with neutrons should be roughly equivalent as “pressurizers” of electrons. If all empirical evidence is against this presumption, the theory should be abandoned forthwith. My impression is that the currently available evidence is mixed. So, let’s have a look at the theory, with the understanding from the start that it may be baloney. The next two sections will discuss the necessary innovative approach to mechanics, which could be justified in principle even if the application to cold fusion is invalid.

Generalization of Quantum Mechanics via a “Covering Theory”

Santilli^{3,4} has indicated the rationale of the *covering theory*. Briefly, theory B is a covering theory of A if B is more richly parametrized (endowed with more symbols) than A and if B reduces identically to A for specified values of the extra parameters. In other words, A is a special case of B. What we shall seek here, in order to put flesh on our introductory skeleton, is a theory B, where theory A is ordinary quantum mechanics.

There being a potentially infinite embarrassment of riches in the matter of possible covering theories, we need some principle to guide us in winnowing out candidate B-type theories. In this, the best—indeed the only—guide is tradition. Quantum mechanics, remember, is a mechanics or dynamics. It did not spring from nowhere. It was fostered by and remains true to a successful dynamical descriptive tradition and was itself formulated through a deliberate application of that tradition: to wit, the process known as “formal Correspondence” with classical point-particle mechanics—based on an advanced formulation of classical mechanics involving canonical transformation theory. (Don’t laugh at a successful tradition in science . . . it’s all we’ve got. Tradition represents the whole learning experience of our species. The rest is smoke and mirrors . . . plus hell paving-stones in the form of good intentions.)

As the name suggests, in formal Correspondence all we are concerned with is the outward “form,” or appearance, of equations. The most relevant form for quantum mechanics, it turns out, is not Newton’s original “force” form, $F = ma$, but a mathematically equivalent “energy” form known as the Hamilton-Jacobi equations:⁹

$$H = -\frac{\partial S}{\partial t} \quad (1a)$$

$$p_i = \frac{\partial S}{\partial q_i} \quad (1b)$$

$$-p_i = \frac{\partial S}{\partial Q_i} \quad (1c)$$

Don’t panic! Quell the math anxiety. All I want you to notice is that there are three of these equations. They all have to be there . . . with fewer than three there is no classical mechanics as we know it (compatible with canonical transformation theory). Later I will have to set down some math, but I’ll try to confine it mostly to an Appendix. All the math knowledge you need here is the ability to count to three. By contrast, in order to handle ordinary quantum mechanics (Schrödinger’s version), you need the ability to count no farther than two:

$$H\Psi = -\frac{\hbar}{i} \frac{\partial}{\partial t} \Psi \quad (2a)$$

$$p_i \Psi = \frac{\hbar}{i} \frac{\partial}{\partial q_i} \Psi \quad (2b)$$

Thus, if you can tell the difference between three and two, you already know more than any living physics Authority or highly-regarded quantum specialist: *You know that the formal Correspondence by which quantum theory was "derived" was botched* by people who could not count all the way to three but got tired at two. Obviously there is no way that three of anything can formally "Correspond" to two. The great mathematicians from von Neumann, Pauli, and Dirac on who gave us quantum mechanics completely overlooked this elementary fact. They continued to claim the existence of a formal Correspondence that literally wasn't all there. Clearly, (2a) formally corresponds to (1a) and (2b) to (1b) . . . but what corresponds to (1c)? One doesn't have to be a mathematician to write down the missing equation,

$$-P_j \Psi = \frac{\hbar}{i} \frac{\partial}{\partial Q_j} \Psi . \quad (2c)$$

There, now . . . you didn't need my help to write that, did you? You, too, can do math—and can do a better job of it than the professionals . . . because you have no trouble counting all the way up to three. Right? Right. Don't let the experts browbeat you into doubting it. (The problem is theirs; their brains are so ponderous they can't readily direct them to trivia such as the difference between three and two. Successive generations of Authorities have amply demonstrated this native incapacity.) Let me assure you that that third equation is just as vital a part of the mechanical tradition as are the other two: One doesn't accomplish canonical transformations between two sets of symbols, (q_j, p_j) and (Q_j, P_j) , by throwing away one of the sets, even if one is smarter than Einstein, richer than Gates, luckier than Clinton, and better-connected than any seven Nobelists.

What is the physics behind the idea of formal Correspondence? It is simply that as we proceed downward on the scale of physical size, considering first stars and planets, next billiard balls, then grains of sand, etc., there exists no abrupt physical discontinuity, no particular place or boundary at which one can say: on this side this set of descriptive equations applies, and on the other side that other set applies. Nature builds smoothly; she does not erect discontinuous walls in the midst of her machinations.

The import of Equation (2c) is that *parameters are missing* from accepted quantum mechanics that are present in the "corresponding" classical theory. These classical parameters (Q_j, P_j) are considered to play the role of "constants of the motion." Without them, classical mechanics would be able to describe only *classes of motions*, not specific ones. It would be a crippled (Liouville-type) theory. And it is to this crippled version of classical mechanical theory that quantum theory formally *corresponds*. Is that the way to build an intellectually respectable particle physics? Should not the Authorities who defend this way of doing business be required to justify their action in omitting (2c), instead of the other way around—that I, as a heretic, am required to justify my recommendation to keep (2c) and the extra descriptive parameters it contains?

I have just said the watchword, "parameters." Did you catch it? There are parameters present classically that are absent from "accepted" quantum mechanics. And let us recollect what is a covering theory: It is a theory B with extra parameters that "covers" theory A from which those parameters are absent. So, here we are with Equation (2c) handing us our theory B, and our needed extra parameters, on a platter. Actually, while we are at it, we might try for even a slight improvement (rigorization) of the formal Correspondence between Equations (1) and (2) by rewriting (2) more generally as

$$H\Psi = -\frac{\partial S}{\partial t} \Psi \quad (3a)$$

$$H\Psi = -\frac{\partial S}{\partial t} \Psi \quad (3a)$$

$$p_j \Psi = \frac{\partial S}{\partial q_j} \Psi \quad (3b)$$

$$-P_j \Psi = \frac{\partial S}{\partial Q_j} \Psi , \quad (3c)$$

where the partial differential operators are understood to act on everything to their right.

Thus, we recognize *all symbols* appearing in the classical equations of motion, Equations (1), as possessed of formal operator analogues. We make no distinction between "old" and "new" canonical variables in this respect. Consequently, to generalize the classical equations, we have only to supply a formal operand or wave function Ψ for the classical-analogue operators to act upon. (There are three equations, but a single operand Ψ suffices for all of them.) In this way it is assured that classical and quantum versions of the mechanical problem are *identically parametrized* and that the basic theme of formal Correspondence is rigorously honored: that there exists no place, no "boundary," in nature and no scale of size at which occurs a discontinuous change in the number or formal inter-relationships of descriptive symbols. This scale invariance can alternatively be viewed as the expression of a Principle of Relativity of Physical Size.⁶ By contrast, the accepted quantum equations, (2a) and (2b), imply that a discontinuity of parametrization exists between the "classical" and "quantum" worlds. Anyone who believes that such a boundary exists should be compelled (under torture, if need be) to specify where it is. Perhaps fair Science has gained less than we thought from eradication of the Inquisition.

Finally, we note several dividends incidental to acceptance of Equations (3). First, (3) is a covering theory of *both* classical mechanics and quantum mechanics. For, if Ψ is taken to be a constant, it cancels from (3) and reduces (3) identically to (1), the classical Hamilton-Jacobi equations from which we started; whereas if in (3) we set S equal to a constant, $S = \hbar/i$, then (3) reduces identically to (2), the equations of ordinary quantum theory. On setting $S = \hbar/i$ and solving (3c), or equivalently solving (2c), remembering that the (Q_j, P_j) are "constants of the motion," we find a solution of the form

$$\Psi = e^{-\frac{i}{\hbar} \sum_j Q_j P_j} \Phi(q_j, t) , \quad (4)$$

where the exponential is just a constant phase factor. The latter cancels from Equations (3a) and (3b), leaving them identical to the accepted equations of Schrödinger quantum mechanics, (2a) and (2b), with wave function $\Phi(q_j, t)$. Thus, by assigning specialized values to the symbols S and Ψ in (3) we reduce that equation to either of the two prior accepted forms of mechanics. But, beyond that, we obtain a further and most crucial dividend in that (3), as it stands with S unspecialized, is something new and thus may be expected to furnish a new mechanics more general than any preceding it. Obviously, if we are lucky, this will prove to be a nuclear mechanics.

It turns out⁶ that we are lucky and that (3) does indeed seem to describe a nuclear mechanics of electron-positrons. This implies that the Heisenberg postulate, which forbids electrons to exist in nuclear bound states, is *disobeyed*. That this can be true is verified at once by evaluating the Heisenberg commutator, $p_j q_k - q_k p_j$. Substituting for p_j from (3b), we find that

$$\frac{\partial S}{\partial q_j} q_k - q_k \frac{\partial S}{\partial q_j} = S \frac{\partial q_k}{\partial q_j} = S \delta_{jk} , \quad (5)$$

it being understood, as we said, that $\partial/\partial q_j$ operates on everything to its right. The symbol δ_{jk} stands for one when $j=k$, zero oth-

erwise. [Equation (5) here is the same as Conte's² Equation (50), except that he identifies the commutator value S as a "biquaternion," whereas we treat it as a simple function of space and time variables.] We note that in the special case $S = \hbar/i$, yielding ordinary quantum mechanics, we do indeed recover the Heisenberg postulate, $\mathbf{p}_i q_i - q_i \mathbf{p}_i = (\hbar/i) \delta_{ii}$. So, the Heisenberg rule is not physically universal but defines that special case in which our new quantity S , the formal analogue of Hamilton's principal function, can be approximated by a constant value throughout all space. Our S -formalism handles the more general case in which local departures of the commutator from constancy are allowed to occur on a subatomic scale.

Such localized variability of the commutator will generate non-potential "forces" in principle beyond the capacity of a physical "potential energy function" to replicate. In this we agree entirely with Santilli.^{3,4} (Still, the calculations given here employ an "effective potential.") Moreover, with the extra equation (3c) adjoined to the energy equation (3a), we have in effect two simultaneous equations for the two unknown functions S and Ψ , so there will be no need to postulate a generalized "Heisenberg postulate" or commutator value. We can simply solve our simultaneous equations of motion, which prove to be necessary and sufficient⁵ to evaluate both S and the wave function Ψ . This constitutes a big step forward in logical economy over quantum mechanics itself, wherein the commutator evaluation demands a separate postulate. In fact in the present theory only Equations (3), the equations of motion, need to be postulated . . . and from that postulate come classical, quantum, and nuclear mechanics, as distinct classes of solution. (Of course, the numerical quantity $\hbar$, descriptive of the atomic class of solutions, has to be known empirically—which is close to, but not quite the same, as postulating it.)

This implies a new relationship between descriptive equations and the world described. Hitherto it has been thought that quantum equations are on all scales of physical description exact, and classical equations are mere approximations. The new perception is that *all* descriptive equations of physics are mere approximations, but that some classes of solution are in certain physical regimes vastly better approximations than other classes. Thus, classical equations of motion are much better approximations than quantum states for the description of stars and planets, etc. Being humble, unpretentious, simple, and clear, this view is anathema to both physicists and philosophers of science.

Quantum Measurement Theory

This brings us to one of the major advantages of our proposed approach to mechanics. It clears up seventy-five years of apologetics for parametric inadequacy in the form of what is known as "quantum measurement theory" (QMT). This apologetics is closely analogous to that by which monotheists account for their belief in a triune god. Just as Mohammedan critics point out to Christians the logical problem that $1 \neq 3$, we have here pointed out to established Correspondence believers that $2 \neq 3$. We can expect (on the basis of experience) that the criticism in both cases will earn an identical reception.

When you are possessed of enough folly but not of enough parameters (because you carelessly threw away half the parameters bequeathed to you by your ancestors), the first thing to do is to substitute a bunch of postulates. Postulates do not really take the place of parameters, but they do take off the heat from your conscience and blind your critical sense by obfuscating whatever issues they contaminate. With enough obfuscation cumulative over enough years, your tracks get covered and your underlying folly becomes undetectable by historians of sci-

ence and ultimately by paleontologists of science. Thus it was that John von Neumann got QMT off to a rousing start with his Projection Postulate. The echoes of that roll down through the years into the new millennium.

The idea is that in order to sever the "von Neumann chain" of phase connections between the observer and the observed it is necessary to override one's postulated equations of motion by a new postulate that contradicts the previous one. The new postulate says, "You have here a pure state because that is what a wave function describes, but a pure state is wrong because nobody can observe that. *Ergo* and *ipse dixit*, by the powers vested in me as an imposing piece of mathematical jiggery-pokery, I declare that suddenly a miracle occurs and a pure state becomes a statistical mixture." The mathematicians loved it (we have already noted their latter-day penchant for mutually contradictory postulates), until one of them suddenly noticed that a mixture is no more observable than a pure state. Thus it was postulate time again, and on this second bash at the problem they came up with a Selection Postulate, which said, "As a result of Projection you now have a mixed state but that is wrong. *Ergo*, etc., I declare that one particular component of the mixture is arbitrarily selected and that is the one actually observed."

Thus at this second stage we have a postulate to contradict the postulate we created to contradict our originally-postulated equations of motion. That had its vogue, but—like second quantization—it suggested that physicists were on the slippery slope of a reduction to absurdity. (If second quantization is good, why isn't n th quantization $n/2$ times better?) Soon such reduction became a challenge: The following era witnessed successive waves of best-and-brightest Young Turks who recognized the science-fictional nature of QMT and went for broke in their zeal to realize the ultimate possibilities of reducing physics and themselves to absurdity. For instance, some of them inflated that tiny original slip—the failure to rigorize formal Correspondence and thereby assure adequate parametrization of mechanics—into an occasion for postulating the existence (the physical existence, mind you) of an uncountable infinitude of universes, in none of which was the von Neumann chain severed at all! Every one of these universes had a big, fat, ever-lasting wave function, like a paper doll it could call its own. So the trumpet that sounded forth the call for QM theorists was heard as, "Send in the clowns!"

More recently the vogue for red-hot postulation seems to have yielded to California *cool*—i.e., to a mantra. A mantra is a verbalism that, if said often enough, convinces the speaker (and his disciples) that he has made a noise worth making. I believe the current QMT mantra goes something like this: "Quantum measurement is an entanglement of the quantum degrees of freedom of the system being measured with those of the measuring apparatus. As a result of the number of degrees of freedom of the latter being large, there is an effective collapse (to zero) of the off-diagonal elements of the density matrix describing the initial system. Hence quantum coherences disappear when the system is allowed to interact with a measuring apparatus or environment."

Take special notice of "quantum degrees of freedom." What are they? In less exciting times, ordinary old degrees of freedom never got entangled with anything more formidable than the law. But quantum degrees of freedom are trickier, fuzzier, more octopus-like, and stickier, too—like burdock—hence more easily entangled with their environment. And, once entangled, they are death on off-diagonal elements. As a neophyte or (perish forbid!) skeptic, you may find something dubious, even laughable, about that mantra . . . but, repeat it often enough, in cadence marked by a sufficiently solemn professor, and you will become a believer. (What an accurate word is that word

“professor!”) The beauty of the mantra approach is that nothing gets nailed down or proven, and there is no paper trail leading back to the original perpetrator—who, likely as not, would turn out to be a computer simulation. (*Simulacrum nihil probat.*) And the goal of higher education is elegantly attained: to get rid of the student as painlessly as possible.

In the seventy-five years since the Projection Postulate shifted the degeneration of physics into hyper-drive, enough QMT purpose-built math fixits have been devised to boggle any would-be critical mind. The view taken here is that mechanics is all of one piece, a piece that fits precisely into a pattern of tradition. But the rats have so industriously gnawed away at that pattern that it has become (during my lifetime) virtually unrecognizable. The biggest rat of all, a super-rat or mongoose, was the great Dirac himself—who, in a fit of inspired misanthropy, devised a special bra-ket notation to disguise the connection of quantum mechanics with the mechanical tradition or with anything else. By the invention of this ingenious notation, Dirac announced that quantum mechanics, his special intellectual toy, was so special that all its links to tradition ought to be severed—this being accomplished through writing its equations in a way that gave equal prominence to operands and operators. Since operands did not appear in classical physics, that automatically destroyed any hope of emphasizing the similarities instead of the differences between the quantum and classical disciplines. In other words, the unity of physics was directly subverted. (His co-conspirators in infamy achieved a similarly subversive goal by subordinating physics to electrical engineering through international adoption of the SI system of units—and through its *rigorous enforcement* by the world’s editorial police.)

Other less spectacular pieces of rat-work within physics included the invention of projection operators, creation-annihilation operators, and density matrices. A whole vocabulary of mathematical devices has come into being, all dedicated to obscuring and drawing attention away from the top-to-bottom unity of particle mechanics. What else would you expect from people who had faked formal Correspondence and thrown away the whole kit-and-caboodle of what were called classically the “new canonical variables” [the (Q_j, P_j)], retaining only the formal analogs of the “old canonical variables” [the (q_j, p_j)]? Half the variables of classical *canonical transformation theory* were unceremoniously discarded, thus gratuitously creating an arbitrary discontinuity of parametrization at the quantum-classical “boundary.” Density matrices in particular emphasize such a catastrophic discontinuity by failing to make any connection with the direct hereditary blood-line joining pure-state (wave equation) quantum mechanics to the energy (Hamilton-Jacobi) formulation of classical mechanics. They possess an entirely different (Liouville-related) heredity. Nothing but the perpetuation of thrice-compounded confusion can result from presenting these interlopers (the density matrices) as fundamental to mechanical description. They are, at best, fundamental to statistical mechanical description, which—despite the name similarity—is another animal altogether.

Having reviewed at excessive length the comical iniquities of the QMT clowns, let me shorten to a few words what I see as the proper resolution of their self-created problem. In the preceding section we saw that any pure-state solution of the quantum equations of motion [the parametrically enhanced Schrödinger equation, Equations (2), including (2c), or Equations (3) with $S = \hbar/i$] must have attached to its wave function a constant phase factor, $\exp(-i/\hbar \sum_j Q_j P_j)$, as shown in Equation (4). It is essential to note that the (Q_j, P_j) constants appearing here are not universal constants—they are *dynamical constants*. This means they are spe-

cial to the chosen descriptive problem. They change when the problem changes. And when they change they do so discontinuously, utterly without causal connection with the past.

Now, in the quantum world, what does it mean that “the problem changes?” It means that something resembling a point event occurs spontaneously in nature. Prior to this, by the nature of a pure state, the problem “stays the same.” This problem-changing occurrence is not the result of human “observation.” It is something that objectively happens “out there,” without debt to human volition or participation. The job of the physicist is to *describe* that happening—not to “enable” it with his inquiring mind, his sterling character, his good intentions, or his pretentious mathematics. Hitherto, he has had no parameters with which to do the necessary job of description. But now, even though the “new” constant parameters (Q_j, P_j) are not observable—hence not numerically knowable—they are *available* to be used to describe (after the fact) the definite place in phase space where the localized physical event occurred.

The old terminology of “quantum jumps” was much nearer to being on-target than any that has since been devised. When a local event occurs in nature, the erstwhile “constant” phase factor on the pure-state wave function describing the associated quantum system “jumps” from one unknowable value to another, thus *destroying phase connections* or “phase knowledge” and severing the von Neumann chain. That ends the quantum descriptive “problem,” and initiates its phase-disconnected follow-on, in which the number of particles may be the same or different (different if one of the particles was a photon that was absorbed, etc.). There, that’s almost all there is to it. No ‘leven postulates a-leapin’, no universes a-splittin’, just a sharp, discontinuous phase jump describable by the *extra parameters* we have been clever enough not to throw away. A million postulates can’t do the work of a few parameters. On both sides of the Correspondence transition mechanical equations of motion logically *suffice* to do the whole job of physical description. There is no boundary, on one side of which equations of motion suffice and on the other side of which discontinuously piles up a mountain of special postulates, special math such as density matrices, special logi-dodges such as paper doll universes.

As a result of equations of motion containing their own phase-severance parametric machinery, phases are all the time being automatically chopped (e.g., by events of absorption of infrared photons within ponderable matter at temperatures above absolute zero), whether we like it or not—so there is no chance for macro objects to stay phase-connected even for microseconds, and of course no “wave function of the universe.” All math description of the physical world is approximation, and the macro parts are usually best approximated without phase connections of any kind in the old-fashioned Newtonian way. Of course, it’s not quite that simple . . . but darned near it. For instance, what about a large quantum system of which a physical event affects only a portion? I don’t address such problems here, but have tried to do so elsewhere.¹⁰

What remains after clearing away seventy-five years’ accumulation of scholarly detritus is austere: just equations of motion to describe nonlocal (“wave”) behavior and ordinary numbers (what Dirac called “c-numbers”) to describe point-like localizations after the fact. History is fact and history happens (“ . . . nor all your tears wash out a word of it.”) The past, a lattice of point events, is distinguished (by its definiteness and parametric describability) from the future, which is not predictable because at the quantum level equations of motion are defined in terms of operators—what Dirac called “q-numbers.” We now have the parameters to *describe* history, in the only way

it can be described—*post facto*. There is retrodiction but no prediction. Thus we obtain, by a minor correction of the quantum formalism, a solution of the famous time-flow asymmetry puzzle. On the physical side there is just the assumption that local events occur by nature's volition. Physicists and their parameters are describers, not enablers, of those events. The only thing wrong with this is the huge number of QMT authorities it puts on the dole. (Did I say "only?" How insensitive of me.)

Whenever I try politely to explain these simplicities to the experts, they patiently explain to me that I "don't understand the problem." This is manifestly true. The problems they are talking about are of vast subtlety and of their own creation. Starting from a laughably non-rigorous formal Correspondence (a botched job that leaves their theory denuded of half its essential parameters), they put postulational and other Band-Aids on their self-inflicted wound and then Band-Aids on the Band-Aids—until, indeed, only minds of a supreme subtlety comparable with their own could hope to cope. Direct intellectual heirs of those medieval philosophers who were beguiled by angels-on-a-pinhead, QMT experts (though abject failures at parameter-counting) are fully capable of perpetrating another millennium of angel-counting. I predict they will succeed in doing this, for basic science in our time has circled back to its static or medieval phase. Santilli³ blames such science on the academies, and I think he has a case. But perhaps the Zeitgeist should share responsibility. Or perhaps the very success of science was what killed it. Although the academies do insistently take all credit for the doing of scientific research, they are not necessarily entitled to *all* credit for the demise of its integrity.

Application to Cold Fusion

By rigorizing the formal Correspondence through which quantum mechanics was originally arrived at, we have here "derived" generalized equations of motion, Equations (3), applicable to all known forms of mechanics . . . and to one (nuclear) form not previously known. The latter is of possible interest for describing "cold fusion" or CANR phenomena. Here I take a plunge into pure (or impure) speculation. The truth is, I don't believe it myself . . . but feel that I cannot leave the matter unexposed to public scrutiny, in view of the importance of finding some theory to guide experimentation in this murky area.

In my original 1960 paper,⁵ as well as elsewhere,^{6,11} I gave a one-body relativistic central force calculation based on a Dirac-type Hamiltonian (energy function). This describes stationary states of electrons or positrons with real energy eigenvalues, $E_j = -mc^2/j$, $j = \pm 2, \pm 3, \dots$, where j is an orbital angular momentum quantum number and m is electron mass. I am told that Majorana did something similar in 1932, but have not seen his paper. The peculiarity of these states is that they lie within what Pauli called the *Zwischengebiet* (the "between-region") lying inside the rest energy limits $\pm mc^2$ corresponding to the electron's self-energy. It can enter this weird region—wherein the particle "weighs less than itself"—only by having imaginary momentum. (The calculation is based on the particle energy relation, $E = \pm \sqrt{p^2 c^2 + m^2 c^4}$, which is the relativistic total-energy analog of the Newtonian expression for kinetic energy, $mv^2/2 = p^2/2m$. Thus p imaginary makes $p^2 c^2$ negative under the square root sign.) This sounds non-physical, but the mass-energy is real; hence the solutions deserve to be taken seriously. Obviously an imaginary-momentum particle cannot be directly observed . . . and this is certainly true of electrons in nuclei. Nobody has ever seen one *in situ*. But transitions to real-momentum states are possible, and are presumably accompanied by radiation of the real energy (and spin) difference as a neutrino. Neutrinos, thus conceived as the

quantum energy "bridges" between real and imaginary-momentum states, are themselves notably strange customers. And that seems to fit with observation, since neutrinos are far from being like other particles, although they most nearly resemble photons.

I shall not rehash these relativistic solutions, since that is all in the literature.^{5,6,11} But I mention them, because the non-relativistic solutions, to which we here turn attention, necessarily make use of some of the previous relativistic calculations. Because I was never able to stir up interest in my 1960 results, I largely dropped the subject for thirty-nine years, until recently seeing the experimental results of Conte and Pieralice,⁷ as mentioned. These suggested to me that there might exist electronic bound-state solutions corresponding to real momentum and real energy, representing an intermediate degree of shrinkage of the electron wave function in the hydrogenic-atom central force problem. Such sub-atomic states could correspond to a non-relativistic Hamiltonian, because of their real momentum, moderate energy, and limited degree of wave-function shrinkage.

What do I mean by "intermediate shrinkage?" There are certain (small) size scales in physics defined by a famous dimensionless number (the fine-structure constant), $\alpha = e^2/\hbar c \approx 1/137$. Starting at the Bohr radius $a_0 = \hbar^2/mc^2 = 0.5 \times 10^{-8}$ cm, we multiply this by α and arrive at the Compton wavelength of the electron, $r_1 = \alpha a_0 = \hbar/mc \approx 3.9 \times 10^{-11}$ cm. A second multiplication by α brings us to nuclear dimensions, "coincidentally" the same as the classical electron radius, $r_0 = \alpha^2 a_0 = e^2/mc^2 \approx 2.8 \times 10^{-13}$ cm. [Here I have used physicists' (cgs) units. The SI unit system thoroughly obscures these simple relationships by gratuitously bringing in the "permeability of the vacuum," μ_0 , and also fouls up the factors of 2π . But what would you expect from the MIT mentalities that successfully politicked for SI?] By intermediate scale, I mean some moderate multiple of the Compton distance r_1 , which lies intermediate between the atomic and nuclear scales.

Considering that a_0 , r_1 , r_0 define three "natural" size scales, it would not be altogether surprising to find that all three correspond to different classes of bound-state solutions of the electronic central (Coulomb) force problem. The atomic bound states (size a_0) are well-known, having been found by Schrödinger. The nuclear ones (size r_0), based on Equations (3), I found to correspond to the relativistic problem with imaginary-momentum solutions. The intermediate-size states (size r_1), also based on Equations (3), are shown in the Appendix possibly to correspond to a non-relativistic central force problem with real-momentum quasi-bound-state solutions, but with unexpected restrictions on the Z -value or atomic number of the attracting nucleus. The analysis in the Appendix is clearly "approximate" because it is non-relativistic. But it is also dubious in other ways, discussed there, so I counsel extreme caution in accepting its results as physically meaningful. Nevertheless, the solutions may be suggestive enough to warrant possible experimental checking. Unfortunately, I am in no position to undertake that myself, so will simply report here and hope to stir the experimental interest of others.

A brief summary of the calculation given in the Appendix follows: The non-relativistic Hamiltonian of the Coulombic central force problem is considered. Using Equations (3), it is readily shown that the radial wave equation assumes a well-known mathematical form provided we use an unconventional "effective potential" of the form

$$V_{eff}(r) = \frac{\sqrt{j^2 - 1} \hbar c}{|j|} \frac{1}{2} \frac{ds}{s^2} \frac{ds}{dr} - E(s^{-1} - 1) - \frac{Ze^2}{r} s^{-2}, \quad (6)$$

where the real function $s = s(r)$ is related to the S of Equations (3)

by $S \equiv (\hbar/i)s$. Thus s , by its departure from unity, describes the degree of local violation of the Heisenberg postulate [see Equation (5)]. This effective potential (related to the “force” on the electron) is unusual in that it depends on the energy eigenvalue E . It also depends on a quantum number j , analogous to the j in Dirac’s relativistic treatment of the H-atom, except that the allowed integral values, $j = \pm 2, \pm 3, \dots$, exclude $j = \pm 1$, which is allowed in Dirac’s theory.

I make the assumption that the s -function previously found by solution of the corresponding relativistic one-body central-force problem,^{5,6,11} namely,

$$s = \frac{1 + \frac{g}{r}}{1 - \frac{r}{k}}, \text{ where } g = jZr_0 \text{ and } k = |\sqrt{j^2 - 1}r_1| \quad (7)$$

can be used in this problem. With the help of (7) the effective potential in (6) is easily evaluated. To render the resulting eigenvalue problem soluble, it is necessary to series-expand the effective potential and to truncate the series after two terms. Even with this simplification the problem involves nonlinearity because of the energy-dependence of the effective potential, Equation (6). The result is a quadratic equation for the eigenvalue E , which has a set of negative solutions corresponding to bound states of size within an order of magnitude of r_1 , as anticipated. However, for a consistent mathematical solution it turns out that the parameter Z , the number of plus charges on the central Coulomb force center (the number of protons in the attracting nucleus) must obey an extra condition, expressible as another quadratic equation, plus the physical requirement that Z be an integer.

The condition that Z be exactly an integer over-constrains the analytic problem. Therefore, in a sense of exact mathematical solution, true eigenstates in this problem do not exist. However, for integral Z -values close to the calculated non-integral value Z_{calc} there may exist “approximately stationary states.” Moreover, genuine eigenstates that last forever are, so to speak, “overkill” in this problem. All that is needed is an approximate or “virtual” eigenstate—a finite-lifetime or semi-stationary state of sufficient duration to allow transitions to other still more localized states, with eventual collapse of the electron into one of the relativistic “nuclear” states of full localization within the nucleus. The energy discrepancy ΔE between the Z_{calc} -state and the nearest integral Z -state permits via $\Delta E \cdot \Delta t \approx \hbar$ estimation of the state lifetime Δt , which turns out to be of the order of 10^{-16} to 10^{-17} sec. This might be long enough to initiate a sequence of collapses of the electron’s real-momentum wave function onto a proton, converting it to a neutron. In that case the final electronic transition would be to a state of imaginary momentum, presumably with neutrino emission. If the neutron thus formed effected a nuclear transmutation or were finally emitted, the efficacy of this particle in producing heat (by nuclear fusion or fission) would depend on the elements present in its vicinity in the host lattice. This is, of course, pure speculation.

Such a line of reasoning suggests that elements in the periodic table, having Z -values near to the calculated Z_{calc} -values corresponding to likely (small) values of the quantum numbers j, l are of particular interest for promoting or catalyzing CANR reactions. The likeliest quantum number values may be the smallest ones; namely, $l = 0, j = \pm 2$. The detailed analysis in the Appendix shows that another quantum number $n' = 0, 1, 2, \dots$, is involved, such that $n' = n' + l + 1$ is an integer. A tabulation of energy quasi-eigenvalues for various combinations of the quantum numbers n', j, l is given in Table A-1 in the Appendix. It will be seen that all calculated energies for the likelier (small)

quantum number values lie in the range of 1 to 10 keV. Since such values are very small compared to the self-energy 511 keV of the electron, this is consistent with a non-relativistic analysis; that is, our employment of a non-relativistic Hamiltonian (energy function) is justified, after the fact.

What does all this suggest about the cold fusion problem? The experiments by now cover a vast range of possibilities extending far outside the original electrochemical arena. But, confining attention to something resembling the original Pons-Fleischmann arrangement, one can speculate on the basis of Mizuno’s evidence⁸ that the heat-releasing nuclear processes may occur mostly near the surface of the palladium cathode, and that “loading” of deuterium or hydrogen into the palladium lattice ought to create there a “pressure” environment affecting any electron present in such a way as to increase the probability of its making a transition into one of the “shrunkened” quasi-eigenstates discussed above. From there the further progress of the CANR is as yet obscure. Collapse through a sequence of increasingly tightly bound real-momentum intermediate states, if they exist, would have to be revealed mathematically by less drastic truncation of the series for the effective potential, and eventually by the use of a fully relativistic many-body Hamiltonian, since the electronic binding energies involved ultimately approach the electron’s rest energy. In this connection I might interject that I am not sure we know how to write a fully relativistic Hamiltonian for the many-body (high- Z) problem. This is not a trivial matter . . . and don’t let any theorist-of-everything tell you otherwise.

Study of Table A-1 in the Appendix suggests that the likeliest element (on the assumption of low quantum numbers) to promote or catalyze collapse (“shrinkage”) of the electron’s wave function within the pressurized palladium lattice environment is zinc ($Z = 30$). There are several other possibilities. Palladium itself is a strong candidate. The fact that its calculated Z -value of 46.056 is quite close (within about 0.1%) to a direct hit on the integer $Z = 46$ implies a fairly narrow energy-spread requirement (line width), hence a quasi-bound state mean lifetime of 8×10^{-16} seconds, which is six times longer than for zinc. But the rather large quantum-number values required for palladium, $j = 2, n' = 2, l = 1$, cast doubt on the issue. Would heating the lattice boost the electron population in higher-number quantum states? If so, “cold” fusion might prove inferior to “luke-warm” fusion. For promoting practical cold fusion, we do not know the relative importance of lower quantum numbers and longer mean lifetimes of the quasi-states.

Suggested Experiment

If the above speculations have any validity, certain experimental tests suggest themselves. For instance, take a “clean” palladium cathode and rub onto its surface some zinc or diffuse this contaminant into the palladium surface. (Plating might be used, but only on one side, to avoid sealing the surface and interfering with hydrogen loading.) Then proceed electrochemically in the established way to load either hydrogen or deuterium into the palladium lattice. (It should not make much difference which is used.) If my speculations are right, there may be some ensuing transmutation of zinc to copper, $Z = 30 \rightarrow 29$ due to neutron formation within the zinc nucleus (i.e., collapse of one of the lattice-confined electrons through a shrunkened state or succession of states onto one of the protons inside the zinc nucleus). An alternative experiment would be to use highly purified palladium and after loading the lattice with hydrogen or deuterium, and allowing reaction time, to look particularly for rhodium (due to $Z = 46 \rightarrow 45$). But it might be hard to find

palladium initially uncontaminated with rhodium.

I place no more faith in such suggestions than does the reader. (I trust we are all skeptics here.) But the experiments may be easy enough to be worth trying. If performed, they dictate caution. For—with astronomically small probability—there could be danger . . . as one is doubtless dealing with a multi-step process, the outcome of which could be a violently nonlinear function of input parameters. One investigator (Andrew Riley, SRI International) has already been killed, unfortunately with nothing learned from the experience.

In conclusion, we reemphasize the shortcomings of the present analysis:

1. A non-relativistic Hamiltonian is used.
2. An “effective potential” (based on an earlier relativistic analysis) is used, where such is not assuredly warranted.
3. This effective potential is series-expanded and truncated after two terms, despite evidence that the neglected terms may be far from negligible.

In connection with the first point, it should be noted that the non-relativistic “shrunk” electronic states derived here are in fact no more shrunk than the K-shell states of the high-Z elements involved. Hence, they are of interest primarily as transitory catalysts of further collapse to fully relativistic states. The second point is serious and possibly fatal to the whole enterprise. The third point represents unfinished business on the side of theory, leading on to interesting mathematics involving generalized continued fractions.⁶ If there is physics in the neglected expansion terms, that could drastically affect the present predictions.

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Appendix: Mathematical Derivation

For the one-body central force problem the classical-analogue Hamiltonian (energy function) has the form, $H = \vec{p} \cdot \vec{p} / 2m + V_{Coul}$, where $V_{Coul} = -Ze^2/r$ is the Coulomb potential energy. (See any book on quantum mechanics.) The model considered here is that of a point electron of mass m at distance r from a point center of Coulomb attraction of positive charge Ze fixed at the coordinate origin. Referring to the equations of motion (3) in the text, we write $S = (\hbar/i)s$ and assume by spherical symmetry that s is a real function of r alone, $s = s(r)$, and that s possesses an inverse. Note that the classical-analogue operators $[H$ and $\vec{p} = \vec{\nabla}S = (\hbar/i)\vec{\nabla}s$, from Equation (3b)] are non-Hermitean, but can be made Hermitean by right-multiplication by s^{-1} . The resulting Hermitean energy and momentum operators, as in conventional quantum theory, being the formal conjugates of time and position, respectively, are the physical “observables.”

Since Equation (3a) may be written $Hs^{-1}(s\Psi) = -\frac{\hbar^2}{2m} \frac{\partial}{\partial r} (s\Psi) / \frac{\partial}{\partial r} (s\Psi)$, we can introduce a new operand $\psi \equiv s\Psi$ and work only with the observable Hermitean energy operator $\hat{H} = Hs^{-1}$. Similarly, Equation (3b) yields $\vec{p}s^{-1}\psi = \vec{p}\psi = (\hbar/i)\vec{\nabla}\psi$ for Hermitean momentum operator $\hat{p} = \vec{p}s^{-1}$. We can ignore Equation (3c) for present purposes, since we shall not need it to determine s and the extra parameters appearing there can be assigned particular constant values that render it nugatory. The energy eigenvalue equation is thus $\hat{H}\psi = E\psi$, where

$$\hat{H} = Hs^{-1} = -\frac{\hbar^2}{2m} \vec{\nabla}s \cdot \vec{\nabla} + V_{Coul}s^{-1}, \quad (A-1)$$

which is Hermitean since s is real. Considering for simplicity only the radial part of the wave equation, and assuming ψ , like s , to be a function of r alone, we can replace partial derivatives with total ones, so that

$$\vec{\nabla}s \cdot \vec{\nabla} = (\vec{\nabla}s) \cdot \vec{\nabla} + s\nabla^2 = \frac{ds}{dr} \frac{d}{dr} + \frac{s}{r^2} \frac{d}{dr} \left(r^2 \frac{d}{dr} \right). \quad (A-2)$$

The resulting radial-wave eigenvalue equation is

$$\frac{d^2\psi}{dr^2} + \left(\frac{1}{s} \frac{ds}{dr} + \frac{2}{r} \right) \frac{d\psi}{dr} + \frac{2m}{\hbar^2} s^{-1} (E - V_{Coul}s^{-1}) \psi = 0. \quad (A-3)$$

This can alternatively be written as

$$\frac{d^2\psi}{dr^2} + \frac{2}{r} \frac{d\psi}{dr} + \frac{2m}{\hbar^2} (E - V_{eff}) \psi = 0. \quad (A-4)$$

Here it will be seen that we are defining the “effective potential” as

$$V_{eff} = V_{Coul}s^{-2} + E(1 - s^{-1}) - \frac{\hbar^2 s' \psi'}{2m s \psi}, \quad (A-5)$$

where primes denote differentiation with respect to r . Obviously this is not a conventional form of potential function, since it depends both on the energy eigenvalue E and on the logarithmic derivative of the wave function. Seemingly, in order to solve (A-4), (A-5) one would have to know the answer in advance.

At this point we must resort to prior art in order to reduce this to the form of a useful potential function. Specifically, we refer to the solution previously given^{5,6,11} for the corresponding relativistic one-body central force problem in order to determine both s and ψ'/ψ . (Our rationale is that a localized violation of the Heisenberg postulate implies effects on the electron requiring a fully relativistic analysis of localized problem aspects, but otherwise may present an eigenvalue problem of conventional structure, governed by a non-relativistic Hamiltonian.) Specifically, from Reference (6), Equations (9.44) and (9.37a), we find that

$$\frac{\psi'}{\psi} = -\frac{\kappa^2}{h} s^{-1} = -\frac{\sqrt{j^2 - 1}}{|r| r_1} s^{-1}, \quad (A-6)$$

where $r_1 = \hbar/mc$ is the electron Compton wavelength. The quantum number j must be an integer chosen from the set $j = \pm 2, \pm 3 \dots$ In the relativistic problem, Equation (A-6) applies separately to each component of a two-component wave function . . . but the components are proportional to each other, so we shall assume that the same relation holds for the present one-component wave function. Finally, from Reference (6), Equation (9.43), we have the result for s given as Equation (7) of our present text, namely,

$$s = \frac{1 + \frac{g}{k}}{1 - \frac{r}{r_1}}, \quad \text{where } g = jZr_0 = jZar_1 \text{ and } k = \kappa r_1, \text{ with } \kappa = |\sqrt{j^2 - 1}|. \quad (A-7)$$

Putting (A-6) into (A-5) to eliminate the wave function, we can express V_{eff} in the manner shown in Equation (6) of the text. Use of (A-7) in the latter leads to

$$V_{eff} = -\frac{\kappa}{j^2} \frac{\hbar c}{2} \frac{(k+g)}{(r+g)} + \frac{E(k+g)}{(r+g)} - \frac{Ze^2}{r} \frac{(r-k)^2}{(r+g)^3}. \quad (A-8)$$

Since g is very small (of order α^2 relative to the Bohr radius, where $\alpha = e^2 / \hbar c \approx 1/137$ is the fine-structure constant), it could be roughly set equal to zero. However, that leads to some apparently spurious solutions. A better approach is to expand (A-8) in series in inverse powers of r . Retaining only the first two inverse powers, we have

$$V_{eff} = -\frac{u}{r} + \frac{v}{r^2}, \text{ where } u = Ze^2 - E(k+g) \text{ and } v = (k+g) \left(-gE - \frac{\kappa}{j^2} \frac{\hbar c}{2} + 2Ze^2 \right). \quad (A-9)$$

The terms of order $1/r^3$ and higher in this expansion are not in general negligible and would need to be considered in a more exact treatment, but will be discarded here. Thus in the present approximation our wave equation (A-4) reduces to

$$\frac{d^2\psi}{dr^2} + \frac{2}{r} \frac{d\psi}{dr} + \frac{2m}{\hbar^2} \left[E + \frac{u}{r} - \frac{v}{r^2} \right] \psi = 0. \quad (A-10)$$

By the substitutions $\rho = \beta r$ and $\psi(r) = R(\rho)$ we reduce this to the standard form of the hydrogenic atom radial wave equation of ordinary quantum mechanics,

$$\frac{1}{\rho^2} \frac{d}{d\rho} \left(\rho^2 \frac{dR}{d\rho} \right) + \left(-\frac{1}{4} + \frac{\lambda}{\rho} - \frac{l(l+1)}{\rho^2} \right) R = 0, \quad (A-11)$$

provided we consider E negative in order to study bound states, and take

$$\beta^2 = \frac{8m|E|}{\hbar^2}, \lambda = \frac{2mu}{\hbar^2\beta}, \text{ and } \frac{2mv}{\hbar^2} = l(l+1). \quad (A-12)$$

The rest of the solution follows any introductory book on quantum mechanics. Substituting $R(\rho) = \rho^l \exp(-\rho/2) L(\rho)$ we find that $L(\rho)$, expressed as a series, obeys the equation for the Laguerre polynomials,

$$\rho L'' + [2(l+1) - \rho] L' + (\lambda - l - 1) L = 0, \quad (A-13)$$

provided the termination condition $\lambda = n - \text{integer} = n' + l + 1$ is satisfied, and strongly diverges otherwise. It is understood that n' and l are non-negative integers. Here L is a polynomial whose highest-order term is proportional to ρ^n . The condition on λ in (A-12) then yields an energy eigenvalue condition

$$\lambda = n = \frac{2m(Ze^2 + (k+g)|E|)}{\hbar\sqrt{8m|E|}}, \quad (A-14)$$

which with the abbreviations $x \equiv |E|/mc^2$ and $y \equiv Za$ can be written

$$n' + l + 1 = [y + x(\kappa + jy)] / \sqrt{2x}. \quad (A-15)$$

The other condition in (A-12), involving v , can similarly be written as

$$l(l+1) = (\kappa + jy)(2jxy + 4y - \kappa / j^2). \quad (A-16)$$

Equations (A-15) and (A-16) constitute two simultaneous equations in the two unknowns, x and y . Unfortunately, because a solution for y as a real number will not satisfy the extra condition that $Z = y\alpha^{-1}$ be an integer, no solution consistent with that condition can be expected. For this reason, as well as our neglect of higher-order terms in the expansion (A-9) for V_{eff} , we cannot obtain physically exact solutions, nor describe *permanently* stationary eigenstates. However, approximate eigenvalues can be obtained by solving the two equations for x , and approximate Z -values (for identifying elements possibly capable of "catalyzing" the rapid collapse of an external electron onto a proton through transitory intermediate pseudo-eigenstates) can be found from the corresponding y -solution. Allowance is to be made here for a measure of optimism (a.k.a. whistling in the dark).

The following iterative numerical procedure for solving (A-15) and (A-16) is found to converge with moderate rapidity:

1. Assume an integer starting Z -value and a set of values of the three quantum numbers chosen from the options $j = \pm 2, \pm 3, \dots$, $l = 0, 1, 2, \dots$, $n' = 0, 1, 2, \dots$. Small values of these quantum numbers are presumably favored, as corresponding to the more probable electronic bound states.

2. Using the initial trial y -value thus determined, solve Equation (A-15) for x . Since it is quadratic, there will be two roots. The physically acceptable root must be a real number between 0 and about 0.2, this upper limit corresponding to the fact that a non-relativistic analysis loses credibility for energy values in excess of about $0.2mc^2 \approx 0.2 \times 511$ keV, since $mc^2 = 511$ keV for the electron self- or rest-energy. One, both, or neither of the roots may qualify. If neither, it can be assumed that the chosen set of quantum numbers does not correspond to a bound state.

3. Using the x -value determined in step 2, calculate y from Equation (A-16). Again, there are two roots, the acceptable one of which, y_{root} , must lie between zero and one (since $y > 1$ corresponds to nonexistent elements having $Z > 137$).

4. From this y -value, evaluate Z_{calc} , the calculated Z -value, by $Z_{calc} = y_{root} \alpha^{-1}$.

5. Compare the starting Z -value with Z_{calc} . The former is an integer, the latter is not. Choose as the next trial value the integer closest to Z_{calc} and repeat steps 2 to 5 until the starting integral Z -value is the closest integer to Z_{calc} – which usually occurs in only a couple of iterations.

If the final Z_{calc} thus determined lies midway between two integers, one may reasonably consider the elements with integral Z -values adjacent to the calculated number to be equally likely (or unlikely) to induce the proton-to-neutron transmutation we are imagining. If it lies closest to some integer, then that integral Z -value is favored. There is zero probability of an exact match. Also, we have *approximated* by truncating our series expansion of (A-8). So no true (infinite-lifetime) stationary state can be anticipated. But we would not want such a state anyway, both because none such has ever been observed and because a quasi-stationary state should suffice to catalyze the electron radial wave function shrinkage we envisage as leading to the proton $\rightarrow$ neutron transition.

Table A-1 lists the numerical values calculated in the *final iteration* of the above procedure for sample values of the three quantum numbers, j , n' , l . Omitted from the table are all of the numerous cases in which the x -roots of Equation (A-15) prove to be conjugate imaginaries, or otherwise fail to meet minimum criteria of physicality. The listing is fairly but not fully "complete" in respect to low quantum numbers yielding quasi-bound states. (Missing entries such as $j = -2$, $n' = 0$, $l = 0$ do not correspond to bound states.)

The table is to be understood as follows: The assumed integer quantum numbers are listed in the first three columns. These integers, together with the integer Z -value listed in the seventh column, are input to Equation (A-15), which is solved to yield the x -value listed in the fourth column. The selected root must satisfy $0 < x_{root} < 0.2$. Next, this x -value is put into Equation (A-16), which is solved to yield the y -value listed in the fifth column. This must satisfy $0 < y_{root} < 1$, as noted above. Multiplying this y -root value by $\alpha^{-1} \approx 137$, we obtain the Z_{calc} value listed in the sixth column. The iteration stops at this point, because the calculated Z -value is nearest to our starting integer Z -value, listed in the next column.

Finally, multiplying x_{root} by 511 keV, we get the quasi-bound state energy listed in the eighth column. And, to give an idea of the spatial extent of the radial wave function, we take note that this is roughly determined by the exponential factor $\exp(-\rho/2)$, where $\rho = \beta r$. Using first equation in (A-12), we find that the mean radial

Table A-1. Electron bound states calculated for non-relativistic Hamiltonian, hydrogen-like radial wave functions, modified by action of non-potential "forces."

j	n'	ℓ	x_{root}	y_{root}	$y_{root}\alpha^{-1} = Z_{calc}$	Z (element)	Energy (keV)	Radius $\times 10^3$ cm	Fraction of Bohr radius
-2	1	0	0.0072 5214	0.2180 8796	29.886	30 (Zinc)	3.7058	3.20	6.1%
-2	2	0	0.0028 7869	0.2171 3140	29.755	30 (Zinc)	1.4710	5.09	9.6%
-2	3	0	0.0015 6312	0.2168 4530	29.716	30 (Zinc)	0.7988	6.90	13.0%
-2	4	0	0.0009 8480	0.2167 1980	29.698	30 (Zinc)	0.5032	8.70	16.4%
-2	10	0	0.0001 9913	0.2165 4947	29.675	30 (Zinc)	0.1018	19.4	36.6%
-2	100	0	2.3492 $\times 10^{-4}$	0.2165 0686	29.669	30 (Zinc)	1.2 Eln. Volts	178	337%
-2	1	1	0.0105 9450	0.4099 4121	56.177	56 (Barium)	5.4138	2.65	5.0
-3	2	0	0.0038 5901	0.2370 7457	32.488	32 (Germanium)	1.9720	4.40	8.3%
-3	1	1	0.0072 5537	0.3050 7200	41.806	42 (Molybdenum)	3.7075	3.20	6.1%
2	2	0	0.0029 4991	0.2158 6955	29.582	30 (Zinc)	1.5074	5.00	9.5%
2	2	1	0.0038 6452	0.3360 8910	46.056	46 (Palladium)	1.9748	4.40	8.3%
3	2	0	0.0040 7981	0.2342 6861	32.103	32 (Germanium)	2.0850	4.27	8.0%
3	2	1	0.0030 6605	0.2878 6080	39.447	39 (Yttrium)	1.5668	4.90	9.0%
-3	1	0	0.0183 9341	0.2423 8982	33.216	33 (Arsenic)	9.3990	2.01	3.8%
-3	1	0	0.0420 5753	0.2515 7307	34.475	35 (Bromine)	21.4913	1.33	2.5%
-5	3	0	0.0032 9568	0.2469 8393	33.846	34 (Selenium)	1.6841	4.76	9.0%
-5	3	0	0.0321 7544	0.2663 7588	36.503	37 (Rubidium)	16.442	1.52	2.9%

extent, $2/\beta = 2h/\sqrt{8m|E|}$, is equal to a distance from the nucleus of $r_1/\sqrt{2x_{root}}$, which is generally of the order of 10^{-10} cm, as listed in column nine of the table. In the tenth column this is also expressed as a percentage of the Bohr radius, which represents the approximate size of the H-atom. It seems well-justified to speak of most of these as "shrunk states," compared to ordinary quantum mechanical states. But it needs to be remarked that the shrinkage is not very impressive (it is less than may be found in the K-shells of high-Z elements), but it is a start toward possible further shrinkage, and is definitely not something to be expected from conventional quantum theory. Even if my speculation is right that such quasi-states transitorily "exist"—intermediate in size scale between the nucleus and the atom—the physics of inducing electrons to enter them remains a matter of art.

An exception to shrinkage arises in the case of very large values of the quantum number n' . This number measures the amount of "wiggling" of the radial wave function (number of zero crossings or distinct radially-nested shells of probability of electron presence). If this number becomes as large as 100, we see from the sixth row of Table A-1 that the electron becomes very loosely bound with an energy much less than that of the H-atom ground state and with a radial extent (of the one-electron zinc ion) three times that of the H-atom. Of course such "bloated" atomic states have never been observed . . . but this

could be because n' values that large are seldom studied and because all these quasi-states are very short-lived.

Usually, Equation (A-15) offers at most one physically possible energy value (x -root). But in certain cases acceptable solutions of (A-15) and (A-16) exist for both x -roots. Two such cases are shown in the bottom four rows of the table. For instance, in the last two rows we have a case in which an electron quasi-bound state of 1.684 keV energy would form around the selenium nucleus as force center, and another of energy 16.442 keV would form around the rubidium nucleus. These binding energies correspond to the x -root values 0.00329 and 0.03217, respectively, both of which easily meet our criterion for non-relativistic analysis, $0 < x_{root} < 0.2$.

The degree of stability of these quasi-bound states can be estimated in the following way. We drop the condition that Z be an integer and carry through the above iterations sequentially until convergence occurs to a compatible pair of real numbers (x, y) that exactly solves Equations (A-15) and (A-16). The x -value so obtained will differ slightly from that computed under the Z -integer constraint previously discussed. Thus, in the case of zinc in the top row in Table A-1, the exact real-number solution has $x_{root} = 0.00719089$ instead of the listed value 0.00725214. The energy difference $|\Delta E|$ associated with this x -value difference is 31.2975 eV or 5.014414×10^{-11} erg. Using the uncertainty relation $\Delta E \cdot \Delta t \approx h$, which is at least roughly valid on the size scale of these states, we thus estimate a mean lifetime for the quasi-bound state of $\Delta t \approx h/|\Delta E| \approx 1.32 \times 10^{-16}$ seconds. Similarly for palladium, which happens to represent the closest match between Z_{calc} and an integer, we find

a lifetime of 8.14×10^{-16} seconds, which is six times longer. Thus the effect of a "near miss" of the real-number Z -solution and an integer is to prolong the quasi-state lifetime (improve its stability). The largest miss in the table is that for rubidium in the last row. The fact that Z_{calc} for that case lies almost exactly half-way between integers has the effect of shortening the mean lifetime of binding to



About the Author

Born in Champaign, Illinois in 1925, he was educated at Harvard in nuclear physics, worked during World War II in P.M. Morse's Operations Research Group in the Navy Department, and subsequently returned to Harvard to do an experimental thesis on molecular beam NMR under Norman Ramsey. His later career included a total of twelve years in the Pentagon, ten in systems analysis for the Navy, and two in research management for the Department of Defense, as well as similar assignments at Navy laboratories in California and Maryland. In 1980 he took an early retirement in order to resume his main interest, physics.

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Scientific American, Fuel Cells, and Cold Fusion

by Jed Rothwell

The July 1999 issue of *Scientific American* features a special report on fuel cells, with three articles: "The Electrochemical Engine for Vehicles," by A. John Appleby, "The Powerplant in Your Basement," by Alan C. Lloyd, and "Replacing the Battery in Portable Electronics," by Christopher K. Dyer.

Fuel cells are similar to cold fusion cells in many ways. They are both electrochemical energy devices that are cleaner and more efficient than conventional internal combustion engines and combustion electric generators. Fuel cells and cold fusion cells have many problems in common, especially with materials, construction, contamination, catalysts, and temperature. A major issue with fuel cells is the cost and availability of materials like platinum and palladium versus the economics and scale of the energy market. Appleby says, "If two million cars with 50-kilowatt electrochemical engines were made every year—about five percent of current auto production—they would use 50 metric tons of platinum, about one-third of the current global production of the metal." In other words, even if the fuel were free, you could not build enough engines with present supplies of platinum. Limited supplies of platinum and palladium may be a problem with cold fusion too, unless nickel-based or titanium-based cold fusion become practical. However, the presumptive hydrogen fuel in cold fusion devices is extracted from water for virtually zero cost—unlike the hydrogen fuel for chemical energy-based fuel cells, which must be generated from water, biomaterials, or fossil fuels at considerable expense using other energy sources. Also, unlike with chemical fuel cells, there will be negligible fuel storage requirement for cold fusion-powered vehicles, since cold fusion energy is thousands to millions of times more concentrated than chemical energy. New types of alkaline fuel cells require only one-fifth as much platinum; thin film palladium cold fusion cells might require only a fraction of the precious metal today's prototypes require. With cold fusion, the problem of limited supplies of precious metals might be solved with improved, energy-intense recycling, such as the technique pioneered at Molten Metals Technology, Inc. Extraction technologies that take advantage of zero-cost energy may also increase supplies. For example, platinum and palladium might be extracted from seawater or low concentrate ores. Fuel cells will not lower the overall cost of energy much (except by reducing consumption somewhat), so they will not make new, energy-intense industries like extracting metals from seawater economical.

Potential applications for fuel cells are exactly like those of cold fusion. There is no particular economy of size with fuel cells. A large, centralized megawatt-scale fuel cell power plant is no more efficient or less polluting than 1,000 decentralized individual kilowatt scale home generators. In fact, a centralized plant would probably be less efficient because of transmission losses (8% per 500 miles according to PG&E). It would probably be more expensive too, taking into account cost of the power distribution infrastructure. As the article points out, home generators are less vulnerable to power outages caused by weather.

Anyone interested in cold fusion should read these articles carefully. They describe how difficult research and development is. Fuel cells remained a laboratory curiosity for nearly a century, despite intense efforts. We hope cold fusion does not

meet the same fate.

Obviously, there is no mention of cold fusion in these articles, since *Scientific American* passionately opposes the subject. There is one connection however. Appleby, an electrochemist at Texas A&M University, reported success in cold fusion experiments in 1989. He has not discussed the work since then, but he never retracted and he did not join the crowd of professors who tried to ostracize Prof. John Bockris for his cold fusion work. *Infinite Energy* Editor Eugene Mallove spoke to John Appleby in 1996 on a tour of Texas A&M University. It was apparent to him that Appleby had not lost interest in cold fusion, even though he preferred to stay out of the "line of fire" of the anti-cold fusion hysteria. Thus were the talents of a great electrochemist diverted to fuel cells. Appleby could have remained in cold fusion research had critics been more reasonable. For the record, the paper, "Anomalous Calorimetric Results During Long-Term Evolution of Deuterium on Palladium from Alkaline Deuterioxide Electrolyte," appeared in the Proceedings of the First Annual Conference on Cold Fusion (March 28-31, 1990), published by the now-defunct National Cold Fusion Institute. Its authors were: A. John Appleby, Young J. Kim, Oliver J. Murphy, and Suprmaniam Srinivasan.¹

An interesting paragraph in the last article describes a new way to store hydrogen for use in fuel cells, which may be better than metal hydride or conventional compressed gas storage:

Recently Terry Baker of Northeastern University announced a form of carbon called graphite nanofibers that boasts almost unbelievable capacity: one gram of the material is reportedly able to deliver 10 liters of hydrogen. Such incredible energy density (equivalent to about 16,000 watt-hours per kilogram) would make other materials pale in comparison. In theory, just half a liter of this incredible substance could power a 20-watt laptop computer continuously for more than a month!

Although this work needs to be more widely reproduced . . .

That comes to 57.6 megajoules per kilogram, which is considerably better energy density than gasoline (42 MJ/kg). It is interesting that *Scientific American* is willing to report this preliminary, not yet replicated breakthrough. Cold fusion would not require large amounts of hydrogen or deuterium, so this storage method would not be of any use.

Footnote

1. "Convincing evidence of anomalous thermal fluxes from palladium cathodes in LiOD solutions is provided. When combined with other evidence for tritium formation, these argue for the existence of solid state nuclear processes in this system. Compared with previous work, effects are only seen at a relatively low level, and they appear to decrease with decreasing electrode surface/volume ratio. They are also observed in a sealed cell with internal gas recombination, which requires no thermodynamic corrections. The effect of lithium ion is seen to be specific, and the effect seems to involve only the palladium surface layers."

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